97-84020-7

Rea, Samuel

Pennsylvania Railroad

[Philadelphia]

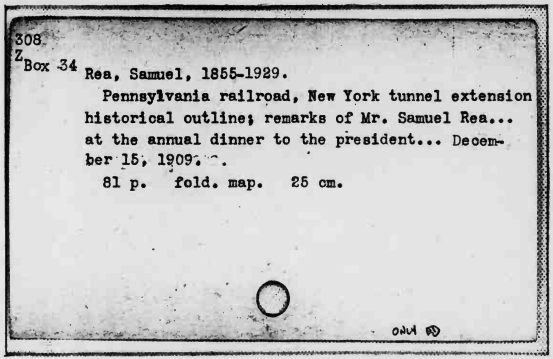
[1909?]

97-84020-7
MASTER NEGATIVE #

COLUMBIA UNIVERSITY LIBRARIES
PRESERVATION DIVISION

BIBLIOGRAPHIC MICROFORM TARGET

ORIGINAL MATERIAL AS FILMED - EXISTING BIBLIOGRAPHIC RECORD


308
Z
Box 34
Rea, Samuel, 1855-1929.
Pennsylvania railroad, New York tunnel extension
historical outline; remarks of Mr. Samuel Rea...
at the annual dinner to the president... Decem-
ber 15, 1909.
81 p. fold. map. 25 cm.

RESTRICTIONS ON USE: *Reproductions may not be made without permission from Columbia University Libraries.*

TECHNICAL MICROFORM DATA

FILM SIZE: 35 mm REDUCTION RATIO: 12:1 IMAGE PLACEMENT: IA (IIA) IB IIB

DATE FILMED: 2-10-97 INITIALS: MS

TRACKING # : MSH 20719

FILMED BY PRESERVATION RESOURCES, BETHLEHEM, PA.

306
3
Pen 34

PENNSYLVANIA RAILROAD

NEW YORK TUNNEL EXTENSION

HISTORICAL OUTLINE

REMARKS OF MR. SAMUEL REA,
SECOND VICE-PRESIDENT, AT THE ANNUAL
DINNER TO THE PRESIDENT GIVEN BY
THE BOARD OF DIRECTORS OF THE
PENNSYLVANIA RAILROAD CO.

DECEMBER 15, 1909

PENNSYLVANIA RAILROAD

NEW YORK TUNNEL EXTENSION

HISTORICAL OUTLINE

REMARKS OF MR. SAMUEL REA,
SECOND VICE-PRESIDENT, AT THE ANNUAL
DINNER TO THE PRESIDENT GIVEN BY
THE BOARD OF DIRECTORS OF THE
PENNSYLVANIA RAILROAD CO.

DECEMBER 15, 1909

MR. CHAIRMAN, MR. PRESIDENT AND ASSOCIATES:—

The approaching completion of our New York Tunnel Extension, which has been proceeding for the past eight years, and your recent inspection of the work, make it appropriate to review the history preceding the determination of this board to extend the system into New York City. My forte—if I have any in the railroad profession—is not, as you know, that of delivering addresses, but, being conversant with all the facts connected with the early history of this great work, and closely identified with its execution, I feel that a brief talk on the subject is due you, and the invitation from our Chairman and this occasion impel me to make the effort.

From popular published accounts of our New York Tunnel Extension one would infer that this exceptional work was suddenly evolved as if by inspiration in the administration of Mr. Cassatt, our late President, whereas it was the logical result of long studied plans in which he participated from the beginning, and the consummation of what was realized as a future necessity by the executive officers, and doubtless many directors of this company, from the time of the lease in 1871 of the United Railroads of New Jersey. I hope to presently demonstrate this statement, for out of those thirty-eight years I can, for the past twenty-six years, speak from personal knowledge.

Mr Cassatt was the last man to be accused of hasty action on such an important matter, or to feel complimented by the suggestion referred to. He was a man of extended experience in the railroad profession, in which he spent his life in the Engineering, Operating and Execu-

tive Departments, of rare knowledge of principles and keen observation, prompt in decision and possessing a cultivated mind and a splendid memory. When he reached conclusions quickly—as he did daily with us—and gave decisions which he rarely had to revise, they were not haphazard, but founded on knowledge, and were the result of exercising instantly the faculty of combining similar experiences and concentrating their teachings on the subject before him—and that is genius.

Let us first briefly review the development of our Company. Chartered in 1846, to build a railroad from Harrisburg to Pittsburgh, it did, after many trials and struggles to provide funds, complete the same in sections, and opened a through rail line for traffic between both cities on December 10th, 1852, thus paralleling the line of public works owned and operated by the State. Until it purchased from the State its moribund canals and railroads it was handicapped by an iniquitous tonnage tax, assessed each year, of five mills per ton per mile from the months of March to December, inclusive, on the tonnage carried over its lines—about two-thirds of the present average rate per ton per mile. This charter provision naively stated that the Winter months —December to February, inclusive—were excluded, because of the impossibility of operating the line during those months with a profit. The facts of course being that the public works as a through route, the canals forming the greater part thereof, were closed during those months.

The purchase from the State was consummated in 1857. The Incline Plane Railroad, known as the "Old Portage Railroad," from Johnstown to Hollidaysburg, had been abandoned in 1855, in favor of the New Portage Railroad, a standard steam road, and upon purchase by the

Pennsylvania Railroad, there being no need of two railroads across the mountains, the track on the New Portage Railroad was taken up and the rails used to aid in completing the Fort Wayne Railroad between Plymouth and Chicago. A part of the Act of Purchase having been declared unconstitutional, the matter was not finally settled until 1859, and the payments to the State were spread over a long period thereafter.

Early in the 60's came the Civil War, but notwithstanding this disturbance to business, considerable progress was made in this decade, notably the leases of the Harrisburg, Portsmouth, Mt. Joy and Lancaster Railroad, the Western Pennsylvania Railroad, and the Philadelphia and Erie Railroad, and the construction and opening for traffic of the Connecting Railway and the Junction Railroad, which gave the Pennsylvania Railroad a through route to New York via Philadelphia, instead of via Harrisburg and the "Allentown Route," and also provided a direct connection with the South at Philadelphia. The Steubenville Extension under Pittsburgh and across the Monongahela River was completed, and furnished the connection with the "Panhandle" System, which since 1869, the Pennsylvania Railroad Company has controlled. In the same year, the Pittsburgh, Ft. Wayne and Chicago Railway was leased, quickly followed by the lease of the Erie and Pittsburgh and the Cleveland and Pittsburgh Railroad Companies, and the formation of the Pennsylvania Company to unify the operation and management of the Lines West of Pittsburgh. At the beginning of 1871, these acquisitions had given the system a place of first rank in that important territory between Pittsburgh, the Great Lakes and the Mississippi and Ohio Rivers, while at the same time other leases and acquisitions had extended it into the Monon-

gahela and Allegheny valleys and other coal fields of Pennsylvania.

Surely the officers and directors of the Company at that time deserve the greatest credit for assuming these obligations, their judgment and courage being based largely on their estimates of the future of the country. These acquisitions, however, only brought them to the city of Philadelphia, and they must have looked longingly towards New York, and wondered how they would ultimately extend the system to the growing commercial metropolis. The only way to reach New York was over the United Railroads of New Jersey or to build their own line. Doubtless grave consideration was given to this feature by those far-seeing men—the directors and officers of that day—but suddenly, as I have been told, they were confronted with the information that if they did not lease the United Railroads, their rival, the Philadelphia and Reading Railway, would, and so the lease was promptly made, to date from June 30th, 1871, but, as usual under such circumstances, on terms very favorable to the lessor. It was at first burdensome to a degree, making heavy annual losses for about seventeen years with the single exception of the Centennial year. Nevertheless it extended the Pennsylvania Railroad to the shores of the Hudson River and by ferriage into New York City, and forever established it there as one of the principal trunk lines. This was vital to its future as an Eastern Trunk Line, and while the direct operations under the lease at first resulted in yearly deficits, the indirect benefits more than compensated for its losses, and of course in recent years the results have been highly profitable. The New York Central, the principal rival of the Pennsylvania, was located in the heart of New York City, and it must have

been a bitter trial to our officers to constantly realize that fact and to have to meet it in a competitive way, which in those early days meant so much more, particularly in passenger traffic, than it does to-day.

We must assume that from the time that lease was made, men like John Edgar Thomson, Thomas A. Scott and George B. Roberts, and the directors who so ably seconded and supported their measures of expansion, must have looked forward to extending the railroad into New York, but the difficulty was not only the great expense but also the lack of a feasible plan, for at that time the engineering obstacles seemed to be insurmountable. Shortly after this lease was made came the panic of 1873, the effect of which lasted for many years, and I believe culminated, so far as our Company was concerned, in the riots and loss of property and business in 1877. During these troublous times no thought could be given to large extensions or to large future requirements, but nevertheless the Company completed its purchase of the Allegheny Valley Railroad, and in this disturbed period continued to develop its local territory by the building of branch roads for coal and coke and other industries, and furnishing improved facilities on its lines.

Specie payments were resumed January 1st, 1879, and the recovery from the effects of the 1873 panic began. The difficulties between the Trunk Lines were a disturbing factor, but there was marked improvement in business and in the speculative markets, which however was interrupted by the assassination of President Garfield in July, 1881. Sharp Trunk Line competition continued and culminated in 1883 and 1884 in a disastrous situation which taxed the resources of the leading lines.

This brings us to President Roberts' administration. He was elected president in 1880, and in 1881 took quick advantage of an opportunity to acquire the Philadelphia, Wilmington and Baltimore Railroad, the purchase of which had been almost consummated by the Baltimore and Ohio Railroad Company.

In 1883 I was appointed the immediate assistant of Vice-President J. N. DuBarry. He had charge of branch lines and the promotion and construction of new lines, and it has been my good fortune to be closely attached to the executive department since that date, except for a few years while out of the Company's service. Mr. Roberts, and other officials of the Company, had already been interested in securing an entrance into New York, because we know that the Hudson Tunnel scheme was brought to his attention. DeWitt C. Haskins started it in 1874, work was later stopped by injunction and not resumed until 1879, and was abandoned in July, 1880, when the community was startled by the loss of twenty lives in the New Jersey shaft due to a "blow out," which stifled the North River Tunnel enterprise for many years.

In 1884 I brought before Mr. Roberts a proposition of Mr. Gustav Lindenthal, C. E., then of Pittsburgh, who had recently rebuilt the Smithfield Street Bridge in that city, maintaining traffic over that notable old Suspension Bridge during construction, whereby the Pennsylvania Railroad could extend its line into New York by a high level bridge over the Hudson. His route was over the Harsimus Cove Branch, rising to a height of one hundred and thirty-five feet above the river and landing at a terminal in the vicinity of Desbrosses and Canal Streets. Mr. Roberts evinced much interest in the presentation of the scheme, and showed a detailed knowledge, which could only have been acquired

by personal study. He seemed to think that while the spans for the bridge were of excessive length—longer than any theretofore built—it might be feasible. At all events he accepted Mr. Lindenthal's dictum that this was practicable, but whether we could locate piers in the river, as contemplated, was at the time an undecided question. He, however, directed me to join Mr. Lindenthal and make a study and report on the subject. This we did and with the shipping men considered the question as to piers in the river, Mr. C. A. Griscom, among other shipping representatives, being consulted, and the United States engineers as well. They all said that piers would never be permitted in the harbor so far down as Canal Street, and they questioned whether any piers would be permitted within the pierhead lines of the Hudson River at New York. We reported this to Mr. Roberts, who seemed disappointed that we should so quickly stop our efforts for a bridge with piers in the harbor, but having canvassed the matter we were firm in our view, and while Mr. Lindenthal assured him that by going further up the river to Castle Point, a bridge could be built with a single span, it did not obtain his approval. To propose a bridge with a span almost twice that of the Brooklyn Bridge was so unprecedented and would have involved so much money, that I wonder now he took as much interest in it as he did; but the panic of 1884 occurring about that time—probably the worst panic experienced in this country as to failures of banks and brokerage houses—put a damper on all new undertakings. Mr. Lindenthal, however, associated with others, all of whom were advocates of a scheme to build a bridge, continued to develop his project for a single span bridge. All thoughtful persons realized at that time that so long as

steam locomotives were the only motive power, the construction of tunnels was out of the question. Work on the old Hudson tunnel opposite Christopher Street had again been stopped in 1882 for lack of funds, though, for the reasons stated, it did not receive any support from our company, and we all looked favorably at that time on a bridge. But we listened to any scheme to get into New York, and I remember giving considerable attention to the Hudson Tunnel at the instance of Mr. Frank Thomson and Mr. Cassatt in connection with General James H. Wilson, who for the time being had taken it in hand.

Mr. Lindenthal and friends in due course applied to Congress for a charter on broad grounds of interstate traffic and the necessity for Federal authority to cross the Hudson and reach the great City of New York, and the project was received with favor; but they did not secure their charter until 1890, and subsequently had the plans for the bridge and approaches approved by the Secretary of War for a crossing at or near Twenty-third Street, with a single span between pierhead lines, and with a terminus in the vicinity of Sixth Avenue and Twenty-sixth Street. Mr. Roberts, Mr. Du Barry, Mr. Cassatt, Mr. Frank Thomson and Mr. Prevost were frequently consulted in regard to the matter, and were always interested, and helpful with advice.

Mr. H. C. Frick and Mr. Percival Roberts, Jr., now Directors of this Company, will recall, on more than one occasion, when they were active in the steel and bridge business, being consulted as to material for this great structure and invited to have their Companies become interested, which was not uncommon in those days in the promotion of bridge companies.

In 1889 I left the service of the Company and went

to Baltimore as Chief Engineer of the Belt Line for the Baltimore & Ohio Railroad Company, and other work, and was able to devote some time to the North River Bridge Company, of which I was one of the incorporators, having assisted in the tedious work before Congress and during the promotion period which followed. Mr. Frank Thomson, I remember, gave me letters of introduction to the late Samuel Sloan, the President of the Delaware, Lackawanna & Western Railroad Company, and other railroad Presidents, whom I saw personally and tried to interest in this scheme. We all felt that by reason of the great cost, it could only be carried out by the co-operation and support of all the trunk line railroad companies, especially as the Company had a Federal Charter and the bridge was to be open to all roads. Along about 1890 a test suit in condemnation was started at the suggestion of Mr. Cassatt, in order to finally ascertain the validity of the charter, there being grave doubt as to whether the Federal Government had a right to charter such a company, and Mr. Cassatt being satisfied that we could never make a successful financial plan until the validity of the charter was fully established. Condemnation proceedings were thereupon incepted in Hoboken for the land upon which the construction of the New Jersey anchorage had been commenced, and the case was carried up and finally decided by the United States Supreme Court confirming absolutely the charter powers of the Company. Meantime two other bridge companies were formed in the States of New Jersey and New York to build a bridge at Fifty-ninth Street, and from time to time they solicited support from our Company. This bridge, however, by reason of its location, did not appeal to any of our officers, and while we kept posted about its affairs, we were not allied with it in any way.

In 1891 I resigned my position in Baltimore on account of ill health, and on the same day I had a message from Mr. Roberts asking me to refrain from committing myself to any professional engagement until he could see me. This was exceedingly gratifying to me, as well as a surprise, for when I left the Pennsylvania Railroad I felt it unlikely that I would ever be invited to return to the service. I immediately saw Mr. Roberts and Mr. DuBarry, and they told me that they would be glad to have me in the service, as there were many engineering questions then pressing them, and others that were coming up, which they desired me to consider in connection with the executive officers. I promised not to make any fixed engagement, and after a needed vacation, to see them before I accepted any other offer. Meanwhile I saw much of Mr. Thomson and Mr. Cassatt, in certain special work for them concerning the anthracite coal transportation questions following the Reading Company's lease of the Lehigh Valley Railroad and the Central Railroad of New Jersey.

In the Spring of 1892 Mr. Cassatt asked me whether I had seen Mr. Roberts lately, and I told him that I had not, but as I was ready to return to work I would, according to promise, see him, which I did immediately. I remember the conversation very well and how Mr. Roberts said, "Well, Mr. Rea, we want you to return to the service, but we cannot pay you as much salary as you received at Baltimore. I think, however, the position will be agreeable to you as well as the work, but we are at a loss as to how to place you in the organization. You know the organization, what have you to suggest?" I said, "Mr. Roberts, the work which you have assigned to me, as I understand it, is to take directions from you on the larger engineering and corporate questions, and also from Vice-Presidents Thomson and DuBarry and co-operate

with them, and, therefore, it seems to me that you should revive the position of Assistant to the President, which has not been filled since the promotion of Messrs. DuBarry and Green to Vice-Presidents, and the death of Mr. Strickland Kneass;" he promptly said, "If satisfactory to you we will do that." We then agreed upon the salary and arranged that I was to make my contemplated trip to Europe, and immediately upon my return take up this work. Mr. Cassatt suggested that I should be elected before going to Europe, so as to be properly accredited by the Pennsylvania Railroad Company, which might help my studies in London of the rapid transit tunnels then building and proposed, and especially the City and South London Railway Company, then in course of construction from the Monument southward under the Thames River.

I sailed on May 25th, 1892, and on the same day was elected Assistant to the President. Upon arriving in London, through my friends, Sir Benjamin Baker and Mr. Greathead, prominent engineers, I was enabled to examine the said tunnel works and other engineering work, and on my return made a report to President Roberts. (See Appendix "A.")

Mr. Austin Corbin, then President of the Long Island Railroad Company, had retained Mr. Charles M. Jacobs, C. E., of London, to make surveys and studies for rapid transit lines in New York and Brooklyn in connection with the Long Island Railroad, and Mr. Roberts was approached with the view of constructing a connecting tunnel from underneath our Jersey City Station, thence under the Hudson River, to a connection with the Long Island Railroad at Flatbush Avenue, in Brooklyn. So when I wrote to Mr. Roberts from England, telling him of the work I had seen and how it might be adapted for rapid transit between Jersey City and New York and Brooklyn,

using electric locomotives, as multiple unit cars had not yet been developed, he evidently was impressed; and doubtless had during my absence considered the matter further with Mr. Corbin and others, for on my arrival in Philadelphia I found a characteristic letter of instructions from him, which I shall read. It shows, I think, how firmly he was then convinced—seventeen years ago—of the necessity for our Company to extend its lines into New York: but the connection then proposed from Jersey City was only for rapid transit and not for regular trains, Mr. Roberts realizing, I have no doubt, that for the latter a different location must be had, and probably hoping that some means would be found to build the bridge. From this rapid transit feature of these tunnels he never swerved, although Mr. Corbin frequently urged him to adopt tunnels of full size.

The letter from President Roberts, dated June 27th, 1892, reads as follows:—

"MR. SAMUEL REA,

"Assistant to the President.

"MY DEAR SIR:—I duly received your letter of the 10th instant from London, acquainting me of the fact that you will sail from the other side on the same day that I will sail from this side. I am going abroad and expect to be back by the middle of September. In the meantime I would be pleased to have you look after such general matters as the Vice-Presidents may indicate, that may require attention, and especially would I be glad to have you see Mr. Cassatt, who has had more or less to do with the question of reaching New York, and take up this subject in its broadest sense. There are three schemes, one a tunnel by which passengers can reach New York and Brooklyn, from Jersey City by

rapid transit cars; the other a bridge scheme, and the last a scheme which has been in my mind of taking such trains as we may wish to run from the upper part of New York across to some suitable locality upon properly constructed ferry boats establishing, in that part of New York, a suitable passenger station.

"All of these matters are in a somewhat crude condition, but the time seems to be rapidly approaching when it would be wise to do something in some one of these directions.

"There are other matters relating to the connection or extension of our lines in one or two directions (which will be indicated to you by Mr. Thomson and Mr. DuBarry), which will require some thorough investigation before we would be prepared to reach any satisfactory conclusion. I have no doubt, however, that you will find plenty to do in my absence in these, or kindred, directions, which will be of much advantage to the Company.

"Very truly yours,

"(Signed) G. B. ROBERTS,

"President."

Pursuant to these instructions I made a careful investigation and report on the schemes outlined by Mr. Roberts (See Appendix "B" for full text), and in addition on one plan that had been suggested by Mr. Cassatt, and to which he had given much thought. It avoided crossing the Hudson River by leaving the main line near Rahway and crossing to Staten Island, but involved a tunnel under the "Narrows" and thence around Brooklyn via the Bay Ridge route, and by bridge across the East River to a terminus at Thirty-eighth Street and Madison Avenue, and a survey of the route had been made

by Mr. Joseph T. Richards, then Assistant Chief Engineer, and now our Chief Engineer of Maintenance of Way. This scheme was inviting to Mr. Cassatt, for while it put the Pennsylvania Railroad into New York, it also made possible a connection with New England either by a tunnel under the East River or via the New York Connecting Railroad, which had been chartered that year—1892—by Mr. O. W. Barnes, C. E. This company, as you know, was afterward purchased jointly by our Company and the New York, New Haven & Hartford Railroad Company. In this report I recommended the North River Bridge project, and gave my reasons therefor, as the best solution of the problem for our Company.

With respect to a floating service for trains to which Mr. Roberts made especial reference, it was very carefully investigated for operation between Jersey City and the foot of West Thirty-fourth Street, where, with transfer bridges, the cars would be placed on tracks that would run in a tunnel under Thirty-fourth Street to a point near Ninth Avenue and turn in under the Blind Asylum property, which flanks our present station yard on the north, where a suitable station was to be located—extending to Eighth Avenue. This appealed to none of us except Mr. Roberts, who evidently thought we must wait so long before a bridge would be built that we should meanwhile use this scheme for part of our service: but we convinced him that it was inappropriate, and as I was fresh from Baltimore and from building an expensive tunnel to supplant an excellent transport service, I could hardly advocate it. As all of our officers favored an uptown station and believed the time had come to establish it, the Twenty-third Street ferry was taken up as a temporary measure until such time as a permanent extension

into New York could be had. Mr. Roberts, however, did not live to see the ferry opened, as he died in January, 1897, and it was not completed for traffic until May of that year.

Mr. Roberts, General Sewell, Mr. Cassatt, Mr. Frank Thomson, Mr. Wayne MacVeagh, and others, in 1892, took a lively interest in the scheme with Mr. Austin Corbin to build a line from underneath our Station in Jersey City, via Cortlandt Street and Maiden Lane, and under the East River to Flatbush Avenue, making their own private subscriptions, and Mr. Jacobs and myself were directed to make the surveys, studies and estimates. This we did, completed the same and organized two companies which afterwards were consolidated. I prepared the financial scheme and the construction contracts and we were ready to go forward, but only for small sized cars doing a local suburban business, as Mr. Roberts always stipulated, although Mr. Corbin was most anxious to have it a full size tunnel.

This was the state of affairs when the silver panic of 1893 struck the country and further consideration was deferred. This scheme, so far as our Company was concerned, while seriously considered at that time, did not appeal to us later, for we all felt that we should devote our energies first towards extending our system directly into a central part of New York City.

Matters drifted along in this way, with Mr. Lindenthal and his friends promoting the North River Bridge project and coming to us frequently for advice and help, which we always gave freely, although as a Company we never contributed anything towards it, but we gave our statistics and used our good offices to interest other railroad companies. It was slow work, and besides it took four or five years to recover from the panic of 1893;

furthermore, the tendency of rates was still downward, and this constant fall in rates caused great anxiety to Mr. Roberts and Mr. Thomson during the latter's brief term as President, and to Mr. Cassatt as well, when he became President in 1899. You are all familiar with the steps he took, which resulted in stopping the cutting of rates, especially in the coal business, in which our Company was so largely interested, and with the investments made in the coal carrying companies, which restored rates and abolished the rebate system. When he saw his way clear to check the fall in rates and get rid of ruinous competition and thus increase the net income of the Company, and of the other companies as well, and enable them to pay a reasonable return to their shareholders, he thought the time had come to seriously consider many improvements and extensions, and among them an extension into New York.

The first evidence of this was the purchasing of a majority of the Long Island Railroad stock in May, 1900, so as to obtain the necessary passenger and freight terminals in the part of New York City best suited to future development. That railroad, its equipment and facilities, were in poor condition, but from his former investigations Mr. Cassatt realized its future as a terminal railroad for the Pennsylvania system, with New England connections. The result of our Company's expenditure in the Long Island Railroad has changed it from a road which made its principal earnings in the three Summer months of the year, with losses in the remaining months, and which did not earn its fixed charges, to a road which now does an all-the-year-round business, and will this year not only earn all of its fixed and obligatory charges, but possibly a small surplus.

The North River Bridge being the only plan which

seemed feasible, the Pennsylvania Railroad Company took the initiative in agreeing to use the bridge with other connecting railroad lines and making its share of the guarantees upon the investment.

The general scheme of the bridge company was to provide for the transportation of nine hundred thousand loaded passenger equipment cars per annum. This traffic was to be furnished by the railroads reaching the west bank of the Hudson River, the Pennsylvania Railroad Company being requested to furnish two hundred thousand of that number per annum, and to pay therefor four dollars per car, with the understanding that the rate per car was to be appropriately reduced when the aggregate number of cars using the bridge facilities exceeded nine hundred thousand per annum. It was estimated that the bridge and approaches, connections and station complete would cost $90,000,000 to $100,000,000; and the general financial scheme of the bridge company was to issue that amount of first mortgage three and one-half per cent. or four per cent. fifty year bonds, and also $50,000,000 of income bonds, of which latter one-half would go to the promoters of the enterprise, and the other half be held as a reserve in the treasury against future contingencies, to pay off existing indebtedness, and for a bonus to the railroads in proportion to the traffic to be furnished by them; the stock of the bridge company to be $1,000,000, and a majority thereof to be held by parties satisfactory to the Pennsylvania Railroad Company.

The Board of Directors of the Pennsylvania Railroad Company acted upon the matter in September, 1900, and Mr. Cassatt was authorized to agree to the request made by the bridge company, and also to ascertain what guarantees of traffic would be made by other lines proposing to use the bridge facilities, and he was requested to report

to the Board from time to time such action as it might be proper for the Company to take in making effective the general arrangement above proposed.

It is needless to say that notwithstanding this action, at the expiration of a year the promoters of the North River Bridge Company were unable to secure the support or co-operation of any other railroad company, and the project seemed too large for the Pennsylvania Railroad to undertake alone, especially as the bridge would be open to other roads.

Matters were, therefore, at a standstill, when in the Summer of 1901, Mr. Cassatt being in Europe, the opening of the Extension of the Orleans Railway in Paris suggested to me that perhaps with the advance in electric traction, thus obviating the use of steam locomotives, we might be able to carry out a satisfactory tunnel scheme ourselves, and I cabled and wrote Mr. Cassatt asking him to look over the Orleans work. This he did, and immediately replied that he was much impressed with it, and he believed it might offer the solution of our problem. The inability to carry out the bridge scheme was a severe disappointment to me as well as to its other advocates, because at that time I believed it was the best proposition, but I realized that if we were ever to build into New York we must do it alone, as we could not get a bridge scheme authorized for any one company. Further, its extension to Long Island, which was then desired by our Company, was not free from difficulties. In fact we intended bringing the Long Island Railroad into New York by tunnel and to a terminus under the proposed North River Bridge Station. Therefore, while disappointed, as I have said, it was my duty to support the tunnel scheme provided it was feasible and would fulfill our requirements. Mr. Cassatt conferred in London with

Mr. Jacobs, who was very familiar with the Hudson River, as he had been retained by parties interested in completing the old Hudson Tunnels for rapid transit, and they returned together: and we immediately started on surveys and estimates for a tunnel extension into New York, and thence to a connection with the Long Island Railroad. At the close of 1901 the Board of Engineers was appointed, and formally organized on January 11, 1902, consisting of General Chas. W. Raymond, chairman; Messrs. Chas. M. Jacobs, Alfred Noble, Gustav Lindenthal, and our Chief Engineer, William H. Brown; and later George Gibbs, then with the Westinghouse Company. The men were eminent in their profession and because of their experience were best qualified for the tunnel work. Mr. Jacobs was made Chief Engineer of the North River Division from the west side of Bergen Hill to the Station Yard, Ninth Avenue, New York; Mr. Noble, Chief Engineer, East River Division, from the New York Station site to and including Sunnyside Yard, Long Island; Mr. Brown, Chief Engineer of the New Jersey Meadows Division, from Harrison to Bergen Hill, and on his retirement was succeeded by Mr. A. C. Shand. Mr. Gibbs was appointed Chief Engineer of Electric Traction and of the New York Station Construction. These men gave fully two consecutive years of consideration to the project, Mr. Cassatt and myself being always at their call, before any part of the work was placed under construction.

You will recall that at the inception of this work we believed it could be carried out with sufficient capacity, through an investment of not exceeding forty to fifty millions of dollars; and I may say that an extension into and through New York, with the station, could have been constructed for that sum. But after an exhaustive examina-

tion it was clearly demonstrated that it would not provide tunnels, stations or yards of the size and character of construction of those we required, nor for future growth, but would have been inadequate after a few years, just as our Filbert Street Extension and Broad Street Station proved to be, and had to be reconstructed nine years after completion. We could not afford to have this happen, and it soon became evident that if we were to extend our System into New York we must do it on a comprehensive basis: and as it was to be constructed for the long future, we had to take into account what the necessities would be twenty or thirty years hence, and build a station and tunnels connected with it that would at least fulfill these conditions, and it is my belief that when the facilities of the present tunnel line, including the additional Thirty-first Street line, for which we have rights, are fully occupied, and the growth of the Company demands additional facilities, other connections and new sites will have to be acquired. This seems to be the correct principle, because there is a limit to the size of a large city station, and the growth of buildings around such a centre and the enhanced values make its future enlargement almost impossible.

You are all familiar with the manner in which the work has been carried out, the difficulties in getting a franchise, the amendment of the Rapid Transit Act, requiring us to go twice to the Legislature of New York, and as our working organization has been detailed in able papers by our engineers, we need not do more than refer to it here. You are also familiar with the severe criticism—written and spoken—which rained upon the Company for a so-called needless and extravagant expenditure of money that would never bring any return directly or indirectly, but happily that is past, and we should be gratified that none of this

criticism came from our stockholders at their annual meetings, and that we have retained their full confidence. I for years had my doubts whether the present generation would fully appreciate this work, and more than once remarked to Mr. Cassatt that it would be like the lease of the New Jersey roads—only fully appreciated long after it was done. I am happy to feel, however, as the work is nearing completion, that people are beginning to see and appreciate what it really means to this great system and to the Western and Southern railroad systems connecting with the Pennsylvania Railroad, and to a large extent dependent on it for New York and New England connections, to have this extension into and through New York City, and a station erected there creditable to our system and well worthy of the greatest city of the country, if not of the world, and ready to acknowledge that if it had not been undertaken at the proper time, it would be practically prohibitive to-day by reason of cost and physical impediments.

The whole work speaks for itself and will stand for all time as a monument to the Company, and to the Directors and stockholders who have so loyally supported it throughout; to the engineers in charge of construction and to the whole staff of the Pennsylvania Railroad Company, for in carrying out the work every department of its service has been utilized, and has done splendid service in bringing to the work its very best experience and judgment, and they have been thus thoroughly familiarised with it in anticipation of its completion and operation.

We early realized that some executive officers must always be in charge ready to give decisions and directions, and while Mr. Cassatt lived he was fully informed and in my absence directed the work. When Mr. McCrea became President the work was well advanced, and while

he was kept in touch with it at all times, it was not necessary for him to then go into the detail, which often engrossed Mr. Cassatt in the earlier days of the work.

The disbursements up to the present time amount to about $102,000,000. The total outlay will doubtless be about $111,000,000, but when we have disposed of our surplus property, I expect the net cost finally to be about $100.000,000, with nearly half that amount written off, so that the book cost will not be much above what we set out to spend.

I can say personally that all questions pertaining to the Tunnel Extension and Station have been carefully considered by the management; every agreement negotiated by the best talent we could secure, and every expenditure so scrutinized that adequate value has been obtained, and every dollar of this large sum has been regularly and properly disbursed and audited.

From this recital of facts, I think you will agree with me that far-sighted men like John Edgar Thomson and Thomas A. Scott must have realized in the early days—as we know Mr. Roberts and his successors did—the necessity for this company to extend its lines into New York, and it should be a great satisfaction to us to have lived to see the great work completed, and the anticipations of so many years realized. But with this satisfaction is the sorrow ever present that Mr. Cassatt was not to see the completion of the work in which he took such a deep interest, and in the plans for which he utilized his ripe experience for the lasting benefit of the public that will use the Station and other facilities.

Notable as were his achievements, many responsibilities and duties are left to us before we can realize the full advantage of so many years of forethought.

It remains for Mr. Cassatt's successor, our worthy President, and for you, the members of the Board, to authorize the remaining feature of the work, namely, the connection with the New Haven System, and I am gratified to see that in this work Mr. McCrea is now engaged. The immediate responsibility is also left to him and to the transportation and traffic officers to successfully operate the Tunnel Extension and demonstrate its great possibilities, and just as the engineering and corporate difficulties were overcome, so I have full confidence that these officers will make it a success that will redound to their credit and to the lasting welfare of the Company.

APPENDIX "A."

A report on the new system of underground transit in London, England, made by Samuel Rea, M. Inst. C. E., Assistant to President Pennsylvania Railroad Company, to G. B. Roberts, President, Pennsylvania Railroad Company. October, 1892.

PHILADELPHIA, PA.

MR. G. B. ROBERTS,
President, Pennsylvania Railroad Company.

MY DEAR SIR:—Your letter of May 27th, 1892, addressed to me in London, with instructions to obtain an insight into such railway matters as might be of use or interest to the Pennsylvania Railroad Company, and especially to devote some time to an examination of existing and proposed underground lines of intercommunication, was duly received.

I spent about eighteen days in London looking into the proposed new system of underground transit, and beg to present the following report on same.

Respectfully submitted,

SAM'L REA,
Assistant to President.

OCTOBER 15th, 1892.

REPORT ON NEW SYSTEM OF UNDERGROUND TRANSIT IN LONDON.

The completion, in 1884, of the "Inner Circle" of the "Underground Railway System" of London was the culmination of a plan for intra-metropolitan railways proposed many years before. From 1884 to 1891 nothing in a comprehensive way was done towards improving the transit facilities between the termini of the trunk railroads, nor for the convenience of crossing London in a north and south direction. In the latter year the City and South London Railway of standard gauge was completed and put in operation with electric locomotives for motive power. The opening of this line marked an era in transit facilities in London, as it inaugurated a new and distinct system of inter-communication without the use of the very objectionable coal-burning locomotive. Four companies have already been chartered, and four or five more will doubtless be authorized by the next Parliament to construct and operate railways similar to the City and South London Railway.

The fact that the street traffic of London had become unmanageable, and passage through the city greatly retarded, doubtless had much to do with the adoption of the new system, for it will certainly reduce the traffic on the streets enormously, and, at the same time, expedite travel.

In speaking of the system as new and distinct, it is in contradistinction of the present "Underground Railway System," operated with steam locomotives, which was originally designed, and indeed carried out, so as to abut upon, if not actually join, nearly all the principal railway termini in the metropolis on the north side of the

Thames. Owing to the location of the said termini this necessitated a roundabout line, which, when joined together, formed what is now known as the "Inner Circle," which affords reasonably rapid communication between the West End and City, and also between the said termini, but does not properly accommodate the densely populated section of the city lying within the lines of the "Inner Circle."

The "Inner Circle" was very difficult to construct and was very expensive, as throughout its length of thirteen miles it was built mostly through and under private property which it was compelled to acquire, and being generally at a depth close to the street surface, it encountered difficulties with sewers, pipes, and the foundations of adjacent buildings, which added materially to its cost. This is not the case with the new system. In designing it the endeavor has been to avoid private property as much as possible, except for station purposes, thus reducing the cost of right of way and real estate to a minimum, and to locate the lines entirely beneath the beds of streets some fifty to eighty feet below their surface, and to there construct two parallel tunnels in a safe and economical way, so as not to interfere with traffic or injure buildings at the street level, nor encroach on rights of abutting property.

In locating the lines of the new system the engineers fit them to such routes of travel and in such sections of the city as were not accommodated by other means of transit, except vehicular, and endeavored to supply transit facilities in localities where the "Inner Circle" has always been deficient. It is an inviting field, and once the new lines are well established they will in all probability earn fair returns on the capital invested, and will in a great measure solve the rapid transit problem of London for a generation at least.

The present "Underground Railway System" is connected, directly or indirectly, with most of the trunk railroads terminating in London, and many suburban trains to and from the trunk railroads run into the city over parts of the "Underground System." This will be quite different on the new system, for with one exception, hereinafter referred to, the new system of railways in low level tunnels will not make direct connection with the existing steam railways, but where the same are intersected, crossed, or approached sufficiently close, exchange stations will be established for the transfer of passengers.

The new system, so far as it has been projected, will comprise nine double lines of railway, namely:—

The City and South London Railway.
The Central London Railway.
The Baker Street and Waterloo Railway.
The Great Northern and City Railway.
The City and South London Ry. (Islington Extension).
The Hamstead, St. Pancras and Charing Cross Railway.
The Waterloo and City Railway.
The Clapham Junction and Paddington Railway.
The Edgeware Road and Victoria Railway.

THE CITY AND SOUTH LONDON RAILWAY.

This is the only railway of the new system which has been completed and put in operation. Parliament authorized its construction by Acts passed in 1884 and 1887, specifying that steam locomotives should not be used in the subways; the language of the Act reading, "Traffic shall be worked by means of carriages propelled upon the system of the Patent Cable Tramways Corporation, Limited, or by such means, *other than steam locomotives*, as the Board of Trade may from time to time approve."

Mr. James H. Greathead was the engineer who designed and carried out the construction of the City and South London Railway. He was also the engineer of the company that constructed the small tunnel, somewhat similar to that of the City and South London Railway, under the Thames at the Tower, in the years 1868-69. This small tunnel was driven through the London clay, and therefore no provision was necessary for tunneling through water-bearing strata, such as was required in the construction of the City and South London Railway. The apparatus invented by Mr. Greathead made the City and South London Railway possible, and through its use the work was carried out more safely, rapidly, and economically than was possible with the means employed on the tunnel previously constructed.

Mr. Greathead is the engineer, or joint engineer, of all the lines herein described as forming the new system of underground transit in London. In addition, he is the associate engineer on a much larger tunnel of similar design for road traffic and pedestrians (hereinafter described), under the Thames at Blackwall, which is being constructed by the London County Council.

When the City and South London Railway was projected and laid out it was intended to use cable power in moving the traffic, and the grades and curves were established with that in view. The maximum gradient against the traffic is one in thirty, or three and one-third per cent., while the heaviest gradient in favor of, or with, the traffic is one in fourteen, or seven per cent., which is a very heavy grade for a railroad. Curves of one hundred and forty feet radius, equivalent to forty degree curves, or much the same as are found on our street railways, are used on the lines. Before the work was

completed electric traction had advanced so far that it was determined to adopt electric power instead of the cable, but it was then too late to revise the curves or lighten the gradients, and the tunnels were therefore completed as originally designed.

The two lines of railway are carried throughout their length in separate tunnels of ten feet and ten feet six inches internal diameter each, and formed of rings of cast-iron segments bolted together through internal flanges. The two tunnels being separate structures and capable of being carried in any position relative to each other, the engineer was thus enabled to construct a double line at some points where otherwise it would be inadmissible without the acquisition of considerable private property. This is well illustrated in this line on the north side of the Thames. After leaving the City terminus the line passes under the narrow way called Swan Lane, at which point the down line is immediately *under* the up line, and both below the bed of Swan Lane, thus avoiding any encroachment upon private property or rights. At each intermediate station, except one on the line, the tunnels are also constructed at different levels.

The manner of constructing these tunnels has been published in the technical journals from time to time, and a detailed statement with diagrams is, therefore, unnecessary in this report. The excavation in the tunnel drift was made with a shield with a cutting edge at its forward end, which was forced forward by six hydraulic rams butting against the finished iron lining of the tunnel, and as the shield advanced the iron lining was placed in position. The iron lining is formed of cast-iron rings of ten feet diameter, and twenty inches wide, composed of six segments and a key piece at the top. The average

rate of progress was thirteen feet six inches per day, but at one face a maximum of sixteen feet per day was maintained for several weeks. The portion under the Thames was constructed without difficulty, and was remarkably free from water—less water being encountered in the workings under the river than occurred at some other points on the route. Where gravel was pierced, compressed air was used to keep back the water. The shield used in the advanced working of the tunnel excavated a circular section somewhat larger than the outside diameter of the iron lining of the tunnel. The annular space surrounding the iron lining was then filled with grout, which was forced in, through holes left in the lining for that purpose, by means of air pressure from a machine in the tunnel. The work of construction was carried out expeditiously and without any delays. The two tunnels cross under the Thames close to and at a lower depth than the foundations of London Bridge, without in any way injuring the stability of that structure.

The line was completed in November, 1890, and opened for traffic on December 18th, 1890. It is three and one-quarter miles long, running from the Monument, near the north end of London Bridge, under the Thames, thence under Borough High Street, Newington Causeway, Elephant and Castle, Newington Butts and Kennington Road to Stockwell.

The track is laid without ballast, and trains passing through the tunnel cause considerable noise; it being of a different sound, however, than usually heard in tunnels, owing to the metal lining.

In addition to the terminal stations at Monument and Stockwell, there are four others, viz.: Borough, Elephant and Castle, Kennington, and The Oval, and the fare for

the whole distance, or between any two stations, is, at certain periods of the day, one penny (equal to two cents our money), but during the busy hours the fare is double this.

All of the station platforms are reached from the street level by means of elevators capable of accommodating a full train load of one hundred persons. Stairs are also provided for those desiring to walk. In order to avoid having stations on both sides of the line, the tunnels at the intermediate stations are constructed at different levels, so that passengers pass readily from the lifts, or stairs, on one side of the road to the platforms of the up and down lines.

At Stockwell, the southern terminus, is located a large plant that generates the electricity used by the locomotives in hauling the trains; it also supplies the hydraulic power for working the lifts at the several stations and for the water ejectors used for clearing the tunnels of any water that may accumulate therein. There are four Edison-Hopkinson dynamos in the power station (at Stockwell), each driven by cylinders seventeen by twenty-seven inches diameter and twenty-seven inch stroke, the steam pressure being one hundred and forty pounds and the piston speed four hundred and fifty feet per minute. At the time this power plant was established at Stockwell the dynamo machines were the largest in use in England for electric traction.

The working conductor which transmits the electricity throughout the line consists of an inverted channel made of steel of high conductivity and laid between the rails. It is fed at intervals by conductors consisting of sixty-one copper wires of No. 14 Birmingham wire gauge, the rails forming the return conductor.

The locomotives are of one hundred horse-power each, and ten tons in weight. They are capable of drawing a train at the rate of twenty-five miles per hour, but the actual schedule time is only about thirteen miles per hour, including stoppages, as it occupies fifteen minutes in going from the monument to the terminus at Stockwell There are sixteen locomotives in use (including spares) and they cost about $7000 each. The axles of the wheels are used as the shafts of the armatures.

The cars used on the line are of the longitudinal type, with platform and entrance at the end, and somewhat similar to the American car. The platforms are wider, however, and are protected with folding gates. The seats run lengthwise of the car, and the height and width is greater than that of the second and third class carriages used on the Metropolitan Railway. To each passenger is allotted about thirty cubic feet of car capacity, while but twenty feet are required by the Board of Trade regulations.

The cars are lighted with electricity and run smoothly considering the sharp curvature of the line. The superstructure of the cars seems light, however, as compared with the trucks, and in passing around the sharp curves they seem to work and wobble, more or less. This will doubtless be much improved on the new lines, as the tunnels on those lines will be eighteen inches larger diameter, the gradients will be lighter and the curves have much larger radii, thus permitting the use of a larger and better proportioned car.

The City and South London Railway was opened for traffic so late in the year 1890 that no returns were given except as to the number of passengers carried, which was 188,182. We are now enabled to give the returns for the year 1891 and the capitalization as of December 31st, 1891, viz.:—

Ordinary Stock ...	$3,149,510	Dividends,	Nil.
Preferential	46,080	"	Five per cent.
Loans	858,000	Interest,	Five per cent.
Total capital ...	$4,053,590		
Gross earnings	$199,400		
Working expenses .	155,185		
Net receipts	44,215		

Total number of passengers carried, 5,161,398. In June of the present year, 1892, the company paid one-half per cent. dividend on the ordinary stock, and reports that the traffic is improving.

The cost, therefore, of constructing and equipping the City and South London Railway, including land, act, preliminary expenses, financing the company, &c. (three and one-quarter miles of double lines), as officially stated and as represented by its paid-up stock and share capital and loans, is $4,053,590. This is equivalent to $1,247,258 per mile, while the cost of the Metropolitan Railway and the Metropolitan District Railway, as they now exist and as represented by their capital and funded debt, is $2,360,000 and $2,250,000, respectively, per mile of line. But it must be borne in mind that these two railways now are, to a large extent, suburban and even country lines. It may be said that this is hardly a fair comparison, for the reason that the metropolitan railways are standard gauge railways, built for and capable of doing a general freight and passenger business in connection with all the other railroads of London, while the City and South London Railway is a separate system and purely a local passenger line. Still, as the metropolitan railways derive more than ninety per cent. of their gross earnings from passengers, they are essentially local passenger lines, and therefore comparable.

Perhaps a fairer comparison would be between the cost of the City and South London Railway and the "Inner-Circle" of the metropolitan railways, which is still more striking, as the latter did not fall much short of $5,000,000 per mile, and according to Sir Edward Watkins, chairman of the Metropolitan Railway Company, the cost of the latest portion of the "Inner Circle" was about $10,000,000 per mile, and these figures would certainly be greater to-day than when the works were constructed.

There can be no doubt, however, of the enormous saving in the laying out of the line and in the method of construction employed on the City and South London line, where the right of way is practically free, as against the Metropolitan railways, which run largely through and under private property and are built for the most part in excavations made from the surface.

The City and South London Railway, with its narrow tunnels, small cars and locomotives, does not impress one favorably when compared with the steam railways. It must be remembered, however, that it is the first line of its kind constructed and operated with electric motive power, and that those which are to follow will have many improvements. The tunnels will be larger, the cars may be larger and more of them to a train, and the average speed faster, although the average speed on the City and South London is faster than on the Metropolitan railways. The engine builders state they can furnish electric locomotives that will haul a train twice the size of those of the New York Elevated Railways, over grades of seventy feet per mile, at an *average speed of twenty-five miles per hour*, not including stoppages for stations.

In discussions on the subject of underground transit in New York some time ago, a pertinent question was asked as to the probable results of precipitating passengers from the street level in hot summer weather to the lower temperature that would exist in the low level of a tunnel. The writer looked into this matter in London, and learned that on the City and South London line there had been no detrimental effects from this cause that had so far been discovered; that in reality the public, during the hot season, preferred transit through the cool atmosphere of the tunnel to other modes of transit on the surface. In the Winter season the temperature is comfortably warm at all times. On June 10th, 1891, the temperature was taken on the street surface and on the platforms in the tunnels, and the following is the record of same, Fahrenheit scale, viz.:—

Stations.	Outside.	Platform.	Difference.
Stockwell.	85.5	62.6	22.9
Elephant and Castle.....	87.5	58.1	29.4
London City Station.....	91.0	63.9	27.1

showing an average variation of about twenty-five degrees.

THE CENTRAL LONDON RAILWAY.

The Central London Railway will be the longest of any of the lines of the new system of underground railways. The main line, extending from Shepherd's Bush to the Royal Exchange, was authorized in 1891, and the extension from the Royal Exchange, underneath old Broad Street, to a terminus underneath the train-sheds and platforms of Liverpool Street Station, Great Eastern Railway, was authorized this Summer of 1892, a total length of about six and one-half miles. The line is shown on the accompanying map in purple, and runs from Shep-

herd's Bush, underneath Uxbridge Road to the Marble Arch, thence under Oxford Street to Bloomsbury, thence under High Holborn, Holborn Viaduct, Newgate Street, and Cheapside to Royal Exchange, thence via the extension under old Broad Street, to the terminus under Liverpool Street Station. As all of the lines of the new system will be authorized to construct similar works, a description of the powers granted this company will apply equally to the others.

In the act of incorporation it is stated that:—

"WHEREAS, Increased facilities for passenger traffic in the central districts of London lying between Shepherd's Bush and the City of London would be of public and local advantage;

"AND WHEREAS, Such facilities can be conveniently provided by means of underground railways constructed in two tunnels (for separate up and down traffic), and to be worked by electricity and to be approached by stairs and lifts, and to be constructed at such depth and in such manner under the public highways as to avoid any interference with the surface or roadway thereof;

"AND WHEREAS, Plans and sections showing the lines and levels of the works authorized by this Act, and also a book of reference to the plans containing the names of the owners and lessees, or reputed owners and lessees, and of the occupiers of the lands required or which may be taken for the purpose or under the powers of this Act, were duly deposited with the clerk of the peace for the county of London, and are hereinafter respectively referred to as the deposited plans, sections, and book of reference."

"Subject to the provisions of this Act the company may make and maintain in the lines and according to the

levels shown on the deposited plans and sections the railways and other works hereinafter described, with all necessary and proper stations, platforms, approaches, passages, subways, tunnels, sidings, shafts, lifts, buildings, apparatus, generating plant, depots, machinery, appliances, works and conveniences connected therewith, and may, subject as aforesaid, enter upon, take, and use such of the lands delineated on the said plans and described in the deposited book of reference as may be required for those purposes;

"*Provided always,* That nothing in this Act shall authorize the company to enter upon, take, or use the surface of any public street or road (other than any street or road which they are by this Act authorized to stop up), but (subject as aforesaid) the company may enter upon, take, and use the subsoil and under surface of any public street, road, or footway shown on the deposited plans and described in the deposited book of reference or so much thereof as shall be necessary for the purposes aforesaid."

The general provisions in said Act as to the mode of constructing the tunnel are as follows:—

"Each railway shall be constructed in two tunnels for separate up and down traffic, and shall be approached by means of stairs and hydraulic or other lifts.

"The tunnels of which the railways consists (including those for the stations) and all tunnels, whether temporary or permanent, shall be constructed by means of steel or other sufficient metal shields driven forward or onward by hydraulic pressure as the work proceeds, such shields being of sufficient length to protect the whole of the soil for a reasonable distance both in front of and behind the working forces. All such tunnels shall be lined

throughout with iron or other sufficient metal plates properly joined throughout.

"Every shaft shall be constructed as a cylinder of iron sunk from the surface of the earth to a depth of at least eight feet below the surface of the London clay at each such shaft. Every such shaft shall, below the said depths, be constructed in manner aforesaid or by underpinning.

"The station tunnels shall not have an internal diameter exceeding twenty-three feet, and the tunnels between the stations shall not (except when necessary for adjustment at curves) have an internal diameter exceeding eleven feet six inches, and the internal diameter of the shafts shall not exceed forty feet.

"Sufficient trial borings shall be kept ahead of the works in all tunnels and shafts in order to ascertain by frequent examinations the nature of the soil in advance of the working faces, and the company may make such borings, subject to such reasonable restrictions as to surface borings as the local authority having the maintenance of the streets may impose.

"Any space between the lining of the tunnels (including stations) and the surrounding soil shall be properly filled up with lime or cement grouting placed therein under pressure.

"Before commencing any of the above works at any point the company shall provide air-compressing machinery sufficient to provide a proper quantity of air at such pressure as will prevent the advent or inflow of any sand, gravel, water, or soil, and the company shall take such precautions that they may at any time during the progress of the work be able to carry out the tunneling under compressed air. All such machinery shall be kept in full working order until the completion of the works in respect of which it is to be used, and shall be used at the working faces whenever the use thereof is for any reason reasonably necessary or prudent.

"Should the nature of the soil extracted by means of the said trial borings be such as to show that it would be reasonably necessary or prudent to work at any working face under compressed air, then the company shall immediately stop all further excavating work and the further driving of the tunnel at such working face until the said machinery and apparatus is in position and in full working order, and the work at such working face shall be carried on under compressed air until the said trial borings shall show that such precautions may be reasonably and prudently dispensed with.

"Except in the case of unforeseen accident or for the purpose of removing rain-water or other trifling amounts of water, no use shall be made of pumping or other modes of removing water from the work. The compressed air shall be used as hereinbefore provided, and so as to restrain the advent or inflow of water into the tunnels."

As to the motive power to be used in the tunnel, the Act provides that "The traffic on the railways shall be worked by means of carriages propelled by electricity."

The capital of the company shall be £2,700,000 of two hundred and seventy thousand shares of ten pounds each.

The company also has power to borrow money on mortgage not exceeding £900,000, with certain restrictions in respect to the capital, all of which said capital must have been first issued and accepted, and one-fifth thereon paid up.

The depth of the railway shall be not less than twenty feet below the surface of any road, measured from the surface thereof, to the extreme top of the tunnel.

The company shall not break up or destroy the surface of any street or road for the purpose of constructing the railway; nor can the company make any openings or ventilators, air shafts, or any similar openings in any roadway or footway.

"The entrances and exits to and from the station buildings, and the waiting accommodations to be provided therein for passengers, shall be so designed and of such extent as to secure the least practicable inconvenience to the public traffic in the adjoining streets, and before the works are commenced plans thereof shall be submitted to the Council in respect of all stations outside the city of London, and in default of agreement the same shall be determined by an arbitrator to be appointed on the application of either party by the president for the time being of the Institution of Civil Engineers."

"In the construction of the railway and works the company shall not permit or suffer any cart or wagon or other vehicle employed in removing from or bringing to the said works any soil, materials, or plant to be loaded or unloaded in any part of the public thoroughfare, and shall not permit or suffer any cart, wagon or other vehicle to carry any soil excavated from the railway or works through the public streets outside the city of London, except in carts or wagons so constructed and managed as to prevent any of such soil dropping therefrom, under penalty of fine for each offense."

"If the railway is not completed within five years from the date of the Act of Incorporation, then on the expiration of that period the powers granted to the company for making and completing the same, or otherwise in relation thereto, shall cease, except as to so much thereof as is then completed."

As to the tolls for passengers, the Act provides that:—

"The company may demand and take for the conveyance of passengers upon the railway any rates or charges not exceeding the following (that is to say):—

"For every passenger conveyed in a first-class carriage the sum of two pence per mile.

"For every passenger conveyed in a second class carriage the sum of one penny per mile."

As to the tolls to be charged for small parcels, the Act provides as follows:—

"The company may demand and take for small parcels conveyed upon the railway any rates or charges not exceeding the following (that is to say):—

"For any parcel not exceeding seven pounds in weight three pence.

"For any parcel exceeding seven pounds, but not exceeding fourteen pounds in weight, five pence.

"For any parcel exceeding fourteen pounds, but not exceeding twenty-eight pounds in weight, seven pence.

"For any parcel exceeding twenty-eight pounds, but not exceeding fifty-six pounds in weight, nine pence.

"*Provided always*, That articles sent in large aggregate quantities, although made up in separate parcels, such as bags of sugar, coffee, meal, and the like, shall not be deemed small parcels, but that term shall apply only to single parcels in separate packages."

As to the regulations of tolls, the Act provides that:—

"The following provisions and regulations shall apply to the fixing of all rates and charges payable under this Act (that is to say):—

"For all passengers conveyed on the railway for a less distance than two miles the company may demand tolls and charges as for two miles.

"Every fraction of a mile beyond an integral number of miles shall be deemed a mile."

With respect to parcels, the weight shall be determined according to the imperial avoirdupois weight.

As to the luggage of passengers, the Act provides that:—

"Every passenger traveling upon the railway may take with him his personal luggage, not exceeding twenty-eight pounds in weight, without any charge being made for the carriage thereof, all such personal luggage to be carried by hand and at the responsibility of the passenger, and not to occupy any part of a seat or to be of a form or description to annoy or inconvenience any other passenger."

"The restrictions as to the charges to be made for passengers shall not extend to any special train run upon the railway in respect of which the company may take such charges as they think fit, but shall apply only to the ordinary and express trains appointed from time to time by the company for the conveyance of passengers upon the railway."

"The company shall not carry on the railway any cattle or other animals, or any goods, articles, or merchandise other than parcels not exceeding fifty-six pounds in weight."

As to cheap fares for the laboring classes, the Act provides as follows:—

"The company at all times after the opening of the railway for public traffic shall, and they are hereby required, to run at least three trains which shall call at every station each way every morning in the week and every evening in the week (Sundays, Christmas Day, and Good Friday and Bank Holidays always excepted,) at such hours, not being later than seven in the morning or earlier than six in the evening respectively, as the company think most convenient for artisans, mechanics, and daily laborers, at fares not exceeding one penny for each journey. *Provided*, That in case of any complaint made to the Board of Trade of the hours appointed by the company for the running of such trains the said board shall have power to fix and regulate the same from time to time. *Provided, also*, That the liability of the company, under any claim to compensation for injury or otherwise in respect of each passenger traveling by such trains, shall be limited to a sum not exceeding one hundred pounds."

Mr. J. H. Greathead and Sir Benjamin Baker, associated, are the engineers of this railway, and are now engaged in preparing it for construction. The railway will serve a densely populated section of the city, running, as it does, underneath the great thoroughfare which bisects London and connects the whole West End with the City. It will command an enormous traffic from the day of opening and ought to become popular and profitable. It will cross the West London Railway at Shepherd's Bush, the "Inner Circle" at Notting Hill Gate, the proposed Baker Street and Waterloo Railway at Oxford Circus, the proposed Hamstead, Saint Pancras and Charing Cross Railway at Tottenham Court Road, the London, Chatham and Dover Railway at Holborn Viaduct, the proposed "Islington Extension" of the South London Railway at the Royal Exchange, and the "Inner Circle" at Bishopsgate Street, at all of which points of crossing exchange stations, with platforms at different levels, will be established. The station at the Royal Exchange will be arranged so as to exchange traffic with the proposed Waterloo and City Railway.

THE BAKER STREET AND WATERLOO RAILWAY.

This line was authorized by Parliament in June of this year, and is now being prepared for construction. It is shown on the accompanying map in green, and will be three miles in length. It extends from Baker Street, just west of the southern limits of Regent Park, thence eastwardly underneath the said park to its eastern limits, thence curving southward it passes underneath Portland Place, Regent Street, Haymarket, Cockspur Street, Northumberland Avenue, and the River Thames to its terminus under Waterloo Station, the terminus of the London and Southwestern Railway. Exchange stations will be established underneath the Thames Embankment with the Metropolitan District Railway, at Oxford Circus with the Central London Railway, and at Baker Street with the Metropolitan Railway and St. John's Wood Line. Traffic will also be exchanged at this station with the Manchester, Sheffield and Lincolnshire Railway when the same has been constructed to a terminus at this point, as authorized by last Parliament. There will be but one other station on this line, and that, an important one, will be located at Piccadilly Circus. The depth of the tunnels will average from sixty to eighty feet below the surface of the streets.

THE GREAT NORTHERN AND CITY RAILWAY.

This line, shown on the map herewith in red, differs from the others of the new system, in that the tunnels will have sixteen feet internal diameter as against eleven and five-tenths feet (and on curves twelve feet) for the others. The Great Northern Railway Company, with its terminus

at King's Cross, has a very large and constantly increasing local and suburban traffic. It has six lines approaching King's Cross terminus, two of which are connected underground with the Metropolitan Railway, over which the Great Northern run frequent local trains to and from Moorgate Street Station in the City. When the Great Northern and City Line of the "New System" was proposed, and the Great Northern Railway Company was apprised of same, the latter company decided to aid in the construction of the new line if the same would accommodate their rolling stock. Whereupon it was agreed between the two companies that the new line should be so built as to accommodate their cars, but not their steam locomotives, and to this end the tunnel sections were enlarged.

The Great Northern and City Line was authorized by the last Parliament to construct a double line from a connection with the Great Northern Railway at Finsbury Park Station, thence parallel with a branch line of the Great Northern Railway, but on a different level, to Canonbury Road, thence underneath said road, New North Road, East Road and City Road to a terminus at Finsbury Circus, adjacent to Moorgate Station on the Metropolitan Railway. Its total length will be about three miles. This line will be purely for local and suburban trains, but will connect with all main line trains at Finsbury Park Station, a prominent junction station on the northern edge of London, and is to be constructed on the Greathead system. The Great Northern Railway Company will deliver its trains to and receive them from the Great Northern and City Line at Finsbury Park Junction, and as steam locomotives will not be permitted to run over the new line, the Great Northern and City Company will operate the trains with electric locomotives between said junction and the terminus of its line in the City at Finsbury Circus.

THE CITY AND SOUTH LONDON RAILWAY—ISLINGTON EXTENSION.

This line, shown in yellow on map herewith, has not yet been authorized. The bill for same was suspended last session owing to the dissolution of Parliament, and will be proceeded with in the new Parliament, when it will doubtless be passed.

To avoid the sharp curvature and heavy grades of the completed City and South London Railway, in connection with its Islington Extension, it is proposed to start the said extension from a point under Borough Road, Surrey, thence by a new line with easy gradients, to pass through new tunnels under the Thames immediately below London Bridge, and thence under King William, Princes, and Moorgate Streets and City Road to the Angel in Islington, a total length of two and one-half miles. This would seem to be a valuable link in the new system. The only wonder is that while they were about it the extension was not projected farther to the westward of the Angel, so as to catch the enormous traffic at King's Cross and vicinity and furnish an additional connection for same with the City.

THE HAMSTEAD, SAINT PANCRAS AND CHARING CROSS RAILWAY.

This line, like the "Islington Extension," has not been authorized, but will be, no doubt, by the next Parliament.

The main line will extend from Charing Cross via and underneath Charing Cross Road, Tottenham Court Road, Hamstead Road, High Street, Haverstock Hill, and Roslyn Street to a terminus near Hamstead Heath, a distance of four and one-half miles. A very important branch of

this line, three-quarters of a mile long, is projected from a point just north of the Euston Road, and will run eastwardly along and underneath Drummond Street (the location of the famous Railway Clearing House) and through private property, with exchange stations to accommodate the great railway terminals of the Northwestern, the Midland and Great Northern Railways; namely, Euston Station, St. Pancras Station, and King's Cross Station. This line is well conceived and will command an enormous traffic at its opening that will greatly relieve the street traffic, and at the same time furnish quick transit between Charing Cross and the termini of the three northern trunk lines—a much needed service.

THE WATERLOO AND CITY RAILWAY.

This line will doubtless be authorized next session of Parliament, as there is no opposition to it beyond that of the South Eastern Railway Company. It is shown in blue on map herewith, and will be in the interest of the London and South Western Railway Company. It will start underneath Waterloo Station, adjacent to the terminus of the proposed Baker Street and Waterloo Railway, and will run thence to the Mansion House, passing under Stamford Street, the River Thames, north end of Blackfriars' Bridge, and thence under Queen Victoria Street below the level of the District Railway (which is already constructed immediately under the surface of that street) to the Mansion House, a distance of one and one-half miles.

There will be no intermediate stations on the line, the principal object being to accommodate the enormous traffic now passing between Waterloo Station and the City, it

being stated upon good authority that fifty thousand passengers arrive daily over the lines of the London and South Western Railway Company at Waterloo Station, and an equal number depart therefrom. As the latter road enjoys a very large local and suburban traffic, it is presumed that a large part of it is made up of people engaged in business in the City who will use the Waterloo and City Railway when the same is completed, as it will afford quick transportation from Lambeth to the City, as well as from Waterloo Station. The journey now occupies perhaps twenty-five minutes by omnibus, and fifteen or twenty minutes by cab, whereas it should not occupy more than five or six minutes when the proposed railway is completed.

The **Clapham Junction** and **Paddington Railway,** to run from Clapham Junction to Paddington Station, the terminus of the Great Western Railway, and the EDGEWARE ROAD AND VICTORIA RAILWAY, from Victoria Station to Brondesbury, via Edgeware Road, each about four and one-half miles in length, are projected lines, and plans will be deposited and bills authorizing their construction introduced in next session of Parliament.

THE BLACKWALL TUNNEL.

The Blackwall Tunnel, hereinbefore referred to, which has recently been put under contract for construction, is not intended for railway traffic, but for street traffic only, and has no connection with the new railway system. Its progress, however, will be watched with great

interest, as the tunnel section will be the largest yet constructed on the Greathead plan.

The London County Council, controlling the matter, determined that a bridge over the Thames at Blackwall was not admissible, and, after mature consideration, adopted the plan for a tunnel to accommodate the street and pedestrian traffic on both sides of the Thames in the vicinity of Blackwall, London.

The tunnel will have an outside diameter of twenty-seven feet and an internal diameter of twenty-four and one-quarter feet. It will consist of a castiron tube built of segmental rings, bolted together through deep flanges and lined with brick and concrete. The total length of the works will be six thousand two hundred feet, four thousand four hundred and sixty-five feet of which will be tunnel (twelve hundred feet only under the river), and an open approach cut on the north side of eight hundred and seventy-five feet, and on the south side of eight hundred and sixty feet.

It will be observed that the new system of underground transit herein described contemplates the construction of a network of railroads located in low level tunnels and aggregating about twenty-five miles in length, and that the routes have been carefully selected, running in many instances under thoroughfares that are at present overcrowded with surface traffic.

Judging from the completed City and South London Railway, and in view of the proposed improvements that will be made on the new lines, it can be truthfully asserted that this system will prove a success in London, or in any other city where the conditions are similar

and the underlying strata the same or of similar material to that underneath the city of London. It must not be supposed, however, that the system is suitable everywhere.

It would be, perhaps, the best adapted of any yet devised for furnishing rapid transit (separate and distinct from the steam railroads and not accommodating their locomotives or cars) between the termini of the trunk railroads in Jersey City and Hoboken and New York City and Brooklyn; the form of construction of the tunnels, however, being adapted to the local conditions, and governed wholly by circumstances and the character of the material through which they would be driven.

If a tunnel is to be constructed through water-bearing strata, the shield method of construction with iron lining would be cheaper in the end than any other, modified, of course, to meet the circumstances, as it can be made to exclude the water, and the permanent cost of pumping many millions of gallons of water daily can thus be avoided. The Severn Tunnel might have been so constructed more cheaply than it was, and the enormous cost of permanently pumping twenty-seven million gallons of water daily from a depth of one hundred and eighty feet would then have been saved. A subway for general traffic, carts, horses, &c., has been authorized under the River Mersey at Liverpool, alongside the Mersey Tunnel—which tunnel is through rock and lined entirely with brickwork—and it is intended to construct it in iron by means of shields of Mr. Greathead's design, he being the engineer of the undertaking.

It is assumed that the cost of these subways is approximately in proportion as the squares of their diameters. Therefore the section of the tunnel has been held

down to the minimum. In the case of the City and South London Railway the tunnels are only ten feet and ten feet six inches internal diameter, which is too small for the proper accommodation of the passengers. The newer ones, as herein stated, will be larger by eighteen inches. Any similar subways built in this country will hardly have a less diameter than fourteen feet, so as to properly accommodate our rapid transit cars, such as are used on the Elevated Railways and the Brooklyn Bridge, New York.

The real secret of the success of the system lies in the fact that the trains are propelled by electricity, and that the coal-burning locomotives are excluded from the tunnels. Tunnels accommodating steam locomotives can be ventilated; that is to say, the smoke can be drawn out and the air renewed as often as required; nevertheless, a tunnel that is subject to the passage of steam locomotives, while perhaps not smoky, soon becomes grimy and disagreeable. The Mersey Tunnel, at Liverpool, is doubtless the best artificially ventilated tunnel in the world. The air throughout its length is renewed about every seven minutes, and the smoke is drawn out almost as rapidly as it comes from the locomotive, but still the sides and arch of the tunnel become grimy and passage through it is more or less diagreeable, owing to the dank smell and to the fine particles of unconsumed coal which are not carried out by the draught so readily —if at all—as is the smoke.

A tunnel operated with electric power can be kept clean and pure at all times, and while the air therein will not be quite as pleasant as on the surface, but more or less musty as occurs in any underground chamber, its advantages are so far ahead of any tunnel operated by steam

locomotives that there is really no comparison. In the City and South London Railway Tunnel no artificial ventilation is necessary. The section being small, and the lines separate, the passage of a train acts as a piston and clears the tunnel, fresh air rushing in at the stations in the wake of the train.

The underground railways of the Metropolitan Companies in London, as at present operated, are dingy, smoky, dirty, and disagreeable, and certainly no one rides through them from choice. This is almost entirely due to the use of steam locomotives. If the management of these railways were alive to the situation they would immediately take steps to change the motive power of their lines, clean out their tunnels, purify them, and afterwards operate their trains with electric power and at higher speed than at present. There can be no question as to the results from such a change—a substantial increase in the passenger business would surely follow. As it is, the companies are barely holding their own, certainly not increasing their passenger traffic as such old established lines running through central London should.

The Metropolitan District Railway has actually lost ground. For in 1886 the total number of passengers carried by it, excluding season and periodical traffic, was about forty-one millions, whereas in 1890 it only carried thirty-six millions.

In the case of the Metropolitan Railway, for the same period it only increased one million four hundred and seventy-eight thousand eight hundred and twenty passengers in the total number conveyed, or about two per cent.

The above is not a good showing at all when it is known that in the five years, 1885 to 1890, all the trunk lines in London increased materially the number of passengers conveyed; some of them making a very heavy increase. The Great Eastern Railway in 1890 carried about fourteen million more passengers than it did in 1885, or an increase of twenty per cent. In the same period the Great Western Railway increased the number of passengers conveyed sixteen and two-tenths per cent.; the London and Northwestern ten and four-tenths per cent.; the Midland Railway about twenty per cent.; the Great Northern Railway nineteen and three-tenths per cent.; the London, Chatham and Dover Railway five and eight-tenths per cent.; the London and Southwestern Railway seventeen and nine-tenths per cent.; and the London, Brighton and South Coast Railway the heavy increase of twenty-five and one-tenth per cent. The traffic on the City and South London Railway is steadily increasing at the rate of about ten per cent. per annum.

Considering these large increases in the passengers carried by the trunk lines, the steady growth of London, the overcrowded condition of its streets, is anything more forcible needed to show that there must be some hindrance to a constant increase in the passenger business of these Metropolitan railways. In the writer's judgment it is accounted for by the use of steam locomotives for motive power, and the consequent disagreeable effect therefrom. Therefore, in proposing to build any tunnels, where large numbers of passengers are expected to use the same, particularly in or near cities, some other motive power than steam locomotives must be provided, else satisfactory results will not follow.

APPENDIX B.

THE QUESTION OF AN ENTRANCE INTO NEW YORK CITY FOR RAILROADS THAT TERMINATE ON THE WEST SIDE OF THE NORTH RIVER.

OCTOBER 5th, 1892.

MR. G. B. ROBERTS,

President Pennsylvania Railroad Company.

DEAR SIR:—Responding to your letter of June 27th, 1892, conveying instructions to take up "in its broadest sense" the question of "Establishing and Reaching a Railroad Terminal in New York City," I desire to say I fully realize, as you have, that this is not a simple task, its study involving what is recognized as one the "World's great undertakings"—on a parity with such works as the Suez and Manchester Ship Canals, and of equal, if not of greater, importance. It has, therefore, been an engrossing subject, and after much investigation and careful consideration I beg to report as follows:—

Many plans have been proposed in the past and a goodly number are now before the public, and particularly before the railroad companies, in one shape or another; some for the purpose of reaching a central terminal station in New York similar to the Grand Central in New York, or the ideal high-level entrance of the Pennsylvania Railroad into Philadelphia, for the railroad companies whose tracks now stop on the New Jersey shore opposite that city; while others, content with a *partial solution*, propose that the termini of the said railroads shall remain on the New Jersey side, but shall be connected with New York by some transit system other than the present ferries.

The railroad situation at New York is unique: A parallel does not exist. Here is a great seaport, with an aggregate population and of commercial importance second to none in the world, separated by the navigable waters of a river from all the rail transportation systems of its country, with but a single exception, namely, the New York Central system.

The completion and success of the Elevated Railways of New York and Brooklyn, together with the completion of the Brooklyn Bridge and other great engineering works elsewhere—notably, the Mersey, Severn and Sarnia subaqueous tunnels and the Forth Bridge (the latter at a cost of nearly $17,000,000, and making a saving of only twenty-five miles in through distance)—calls pointed attention to the unsolved problem of an entrance and a terminus in New York for the railroads stopping at the edge of that city.

To show the great necessity for an entrance into New York City (from the standpoint of passengers only) that will provide for the enormous traffic crossing the North River, and for the large increase that will surely follow the completion of such an undertaking, the following statement is submitted giving the number of passengers crossing the North River in 1890 (local and railroad passengers separately), also the number of trains running on the several railroads connecting with the ferries. This statement was compiled with great care, and is based on the best and most reliable data obtainable:—

STATEMENT OF PASSENGER TRAFFIC ACROSS THE NORTH RIVER

IN THE YEAR 1890:

AS PREPARED BY THE NORTH RIVER BRIDGE COMPANY.

Location of ferry and railroads connecting therewith.	Local passengers between New York, Jersey City, and Hoboken.	Railroad passengers arriving and departing.	TOTAL.	Number of passenger trains per year.
Liberty St. Ferry connects with Jersey Central R. R., Phila. & Bound Brook R. R., and other railroads....	2,680,500	8,519,500	11,200,000	80,371
Cortlandt St. and Desbrosses St. Ferries connect with Pa. R. R., Lehigh Valley R. R., Susquehanna & Western R. R., and other railroads.....	11,603,800	7,418,100	19,021,900	70,044
Chambers St. and West 23d St. Ferries connect with N. Y., L. E. & W. R. R., Northern R. R. of New Jersey, and other railroads....	2,071,500	8,608,000	10,679,500	81,207
Barclay St. and Christopher St. Ferries connect with D., L. & W. R. R., Morris & Essex R. R., and other railroads.....	16,912,000	7,728,000	24,640,000	72,905
Jay St. and West 42d St. Ferries connect with the West Shore R. R., Ont. & Western R. R., and other railroads.....	1,857,000	2,051,000	3,908,000	19,349
West 14th St. Ferry to 14th St., Hoboken.....	2,810,000	.....	2,810,000	.....
Total.....	37,934,800	34,324,600	72,259,400	*323,876

* Total passenger trains on all roads in the year 1890.

The annual number of ferry passengers on the North River has grown from 58,894,300 in the year 1886 to 72,259,400 in the year 1890, being an increase of 23,364,900 passengers, or forty per cent. during the last five years. Four-fifths of this increase was made up of railroad passengers. The increase of the next five years will be at least equal, if not greater, so that the number of ferry passengers on the North River in 1897)about the date of completion of any entrance into New York that may be begun soon) will probably exceed one hundred million, of which forty-five million can be taken as railroad and fifty-five million as local passengers.

It is presumed that New York will in the near future be well provided with local transit facilities. Cable railways are being constructed on Broadway and Third Avenue; consolidation of surface lines is going on constantly, with the expectation that one company will ultimately control the whole system and then adopt electric or other suitable power in lieu of horses; the Elevated Railways doubtless will secure additional powers, not to extend, but to widen their lines, and thus be enabled to provide better facilities and furnish real rapid transit for their phenomenal traffic, which seems to be limited only by the facilities afforded; then it is possible that an underground system may also be established and operated by electric power: all of which is mentioned for the reason that any terminal established in New York must be accessible from all parts of that city and Brooklyn, and necessarily closely connected with the rapid transit systems of both those cities. Furthermore, any entrance into New York should provide for local transit between that city and the nearby cities in New Jersey.

At the outset we must assume that it is not worth while to consider the question of running "solid" pas-

senger trains through tunnels underneath the Hudson River drawn by steam locomotives, with their attendant smoke and dirt, vitiating the air and requiring expensive provisions for ventilating, which, after all, will not do away with the inconvenience and discomfort to passengers. Even if coke or oil should be used for fuel, the result would be practically the same, for, while there would be less smoke, the gases emitted from the locomotives would be quite as deleterious as if coal were used.

Having reviewed the situation, we are now prepared to take up the various projects that have been presented as a solution, or a *partial* solution, of the problem of a railroad entrance into New York and the establishment therein of a terminal station. Certainly the first thing to do is to outline all feasible projects worthy of consideration, discuss them practically, furnish estimate of cost, and then endeavor to reach some conclusions of practical value.

There are before us only five projects which are considered worthy of special consideration. Three of these would furnish an indirect entrance or, as before stated, a *partial* solution of the problem, while two contemplate a direct entrance for "solid" trains running at express speed to a suitable city terminus in New York, making important connections with other existing steam railroads and with certain proposed lines, and also connected with the rapid transit systems of both New York and Brooklyn. One project, which has been spoken of frequently in the public prints, known as the New York and New Jersey Bridge Company, is not herein considered, for the following reasons: First, because its location, as shown in dotted line on map herewith, is so roundabout, as it crosses the North River five miles above Jersey City and then descends two or three miles southward into New York

to a proposed terminus, that it would not be a proper entrance for the Pennsylvania Railroad Company, and has never been seriously considered by it. Second, because that bridge company has no authority to build a bridge with railroad tracks, and has not received any national sanction therefor. Third, because there is nothing to indicate that the company has ever designed or adopted a suitable plan for bridging the Hudson River, which at that point is wider than below at Hoboken, and would necessarily require an extraordinary structure. All of these five projects, marked A, B, C, D, and E respectively, are shown on map herewith, together with proposed connections, and outlined as follows:—

(*a.*) An underground system of rapid transit, separate and distinct from the steam railroads, similar to the City and South London Railway, London, connecting Jersey City Station with New York and Brooklyn or with New York alone.

(*b.*) The completion of the partially constructed Hudson River tunnel (for one track), to be followed by the construction of others parallel therewith, the tracks through the same to be connected with the existing steam railroads on the New Jersey side, for the accommodation of passenger traffic only. The steam locomotives to be detached on New Jersey side and trains hauled through tunnels by cable power to a terminus in New York, south of Washington Square.

(*c.*) The establishment in New York, on the west side, of a suitable railroad terminus, connected with the Eleventh Avenue tracks of the New York Central Railroad, the proposed Forty-second Street tunnel line to Long Island, and also reached by the elevated railways, and

connected with Jersey City Station by means of floating equipment carrying "solid" trains similar to the present steamer "Maryland" service.

(*d.*) The establishment of a terminus in New York, fronting Madison Avenue, and between Thirty-seventh and Thirty-eighth Streets, to be reached by a double-track railroad thirty and one-half miles long, extending from a connection with Pennsylvania Railroad at Houtenville, just west of Rahway, to and over or under Arthur Kill to Staten Island, and thence by subaqueous tunnels three and one-half miles long under "The Narrows," between Upper and Lower New York Bay, to a connection with the railroads on Long Island, and thence by same and new lines through, or rather around Brooklyn to Hunter's Point, to a high-level crossing of the East River, the several streets and the East Side elevated railroads to the proposed terminus. Said terminus could also be utilized for New England railroads via the proposed line from a connection with the Forty-second Street tunnel line and the Long Island Railroad in Long Island City; thence to a high-level crossing of the East River at Hell Gate via Ward's and Randall's Islands, and thence to the main shore to a connection with the New Haven or New England railroad systems, as shown on map.

(*e.*) By a high-level bridge over the Hudson (or North) River to a terminus, for passenger and freight business, at suitable points between the said river and Broadway, the passenger station to be located on Sixth avenue in the vicinity of Madison Square. Said bridge and terminus to have ample tracks and to accommodate the regular trains and traffic now running to Jersey City

terminus, or as much thereof as may be deemed advantageous to send into New York. Bridge to accommodate the heaviest trains at express speed and to have assigned tracks for rapid transit, said tracks to connect with all rapid transit systems thereabouts, including Jersey City, Bergen, Staten Island, Newark, &c. The station in New York to be directly connected with the elevated trains of the Ninth and Sixth Avenue lines, and with the rapid transit surface lines. Station also to be connected by a spur with the tracks of the New York Central and Hudson River Railroad on Eleventh Avenue, and the tracks through the proposed tunnel under Forty-second Street, and thence with the Long Island Railroad system, the city of Brooklyn, and the proposed "Hell Gate Line" for New England.

Having outlined the several projects under consideration, we will now take them up *seriatim:*

PROJECT A.

This project, proposed as a connection for the existing steam railroads, has been thoroughly examined by Mr. Austin Corbin, and under your direction Chief Engineer Brown also made some investigations and reported thereon with an approximate estimate of cost. As a *partial* solution of the problem under consideration, this project is perhaps the best of any we have before us. Eliminating the idea of connecting it directly with any existing railroad (as was proposed by Mr. Corbin) we will consider it solely from the rapid transit standpoint. The line from Jersey City Station to a terminus on Atlantic Avenue in Brooklyn will be two and seventy-four one-hundredths miles long, and will be in tunnel throughout. As about one-third of the length of the

line will be through "soft ground," that portion at least should be constructed with two tunnels, each carrying a single-track railroad. That mode of construction has many advantages, both during construction and in the operation of the railroad. The grades can be so arranged if desirable as to have the steepest part always with the traffic. In case the line runs under a narrow street the two tunnels can be put in the same vertical plane (one above the other), and encroachments on abutting property thus avoided. The section of tunnel being much smaller for single than for double track, the structure can be made more secure and stable, particularly in "soft ground," where it should be lined with iron, and being grouted around its outer circumference there would be scarcely any leakage, and in consequence the pumping for drainage would be a small item. Then in a single-track tunnel, with traffic operated by electric power, no special ventilating plant is likely to be required, as the passage of a train would act as a piston, and the air within the tunnel would practically be renewed by the passage of every train.

Stations on a railroad of this character are expensive appurtenances, and there should be as few as proper regard for the traffic will admit. It would seem that a terminal station at each end of this line, with one large intermediate station in lower New York—the latter properly located to exchange traffic with all the transit lines in that city—would be sufficient.

The western terminal station of this underground railroad should be immediately underneath or in proximity to the train hall of the Pennsylvania Railroad Station in Jersey City, and at such depth as would be determined upon after the grades of the lines were established; the station to be reached by stairs and elevators located in or near the

lobby of the Pennsylvania Railroad Station, each elevator or pair of elevators to have a capacity equal to the capacity of a train on the underground railroad. The terminal station in Brooklyn should be of similar design to the one in Jersey City, taking into account the traffic of the Brooklyn elevated railways and of the surface lines. The station in New York would be a "through" station, and should be ample in size, with rapid-running elevators, and the whole place kept scrupulously clean and light. Notwithstanding the line through New York would be within rock formation, and at such depth that it would cause no damage to any buildings if it were constructed underneath same, it would be advisable to avoid any complications of this kind; therefore the line through New York should follow the line of the streets, if possible.

The portion of the line from New York to Brooklyn is so simple of construction lying wholly within the rock, that it might be advisable to build it first; besides, there is not much doubt of the profitableness of that portion of the line when completed. That part, however, underneath the North River, while feasible, will cost more, and the result is somewhat uncertain as compared with the other, or might require a longer time before it becomes profitable. But as it is the essential part for the Pennsylvania Railroad Company, there is no reason from its standpoint why it should be delayed beyond the commencement of the Brooklyn end. The cost of such a double-track line complete, ready for traffic, from Jersey City to Brooklyn, via the Battery, with stations at the termini, and with one intermediate station in New York, would not exceed $6,500,000. It might be desirable for the Pennsylvania Railroad Company to promote the construction of a double line of this character straight across the river from Jersey City to a point, say, under Cortlandt Street, leaving the Brooklyn end to be taken up

as a separate undertaking, and, if so, it can be constructed ready for traffic for about $4,000,000. There is considerably more silt formation and correspondingly less rock on this route than to the Battery, and as the iron-lined tunnel costs a great deal more than ordinary tunnel work, this accounts for the disparity in estimates.

PROJECT B.

Work on the Hudson River tunnel was commenced some thirteen years ago and has been continued ever since, with occasional stoppages on account of accidents or lack of funds to carry it forward. The original project was for two separate tunnels, each having an average horizontal diameter of fifteen feet and vertical diameter of about twenty-two feet, and each designed to carry a single track, constructed with an outer lining of wrought-iron segmental plates bolted together and an internal lining of brick masonry. Owing to the insufficiency of the thin wrought-iron skin the design was afterwards changed and strengthened. One tunnel has been completed for the greater part of the distance under the river, but recently all work has again been suspended.

One peculiar feature of this project is that no definite arrangements have ever been made for the terminus on the New York side. The original intention was to connect with the existing steam railroads on the New Jersey side, and arrange for the running of trains from those railroads through the tunnels to a terminus in New York City.

There is a well-grounded theory among engineers and railroad men that it is not desirable, even if it is practicable, to run "solid" steam railroad trains without change of power through such a tunnel so close to the

terminus in New York, and therefore, as heretofore stated, this feature will not be considered.

We have evidence recently of a revival of interest in this tunnel in the printed report made by Mr. C. W. Buchholz, C. E., and late chief engineer of the New York, Lake Erie and Western Railroad Company, to Mr. James H. Wilson, who is either now the president of the Tunnel Company or is looking into the project with a view of accepting that office. This report, with diagram of proposed station, appeared in the "Railroad Gazette" of August 12th, 1892. The substance of the report was as follows: That there should be constructed under the river four tunnels, each carrying a single-track railroad, to be connected on the Jersey side with the New Jersey Junction Railroad running along the foot of Bergen Hill, so as to connect with and accommodate the traffic of all the trunk lines on that side of the river, the tunnels to extend under New York City to a point south of Washington Square, where they would connect with station tracks to be located between Third Street on the north, Bleecker Street on the south, and between Green Street on the east and Sixth Avenue on the west; there to establish a large passenger station with twenty tracks and ten platforms, all to be located below the street level. In order to obviate some of the disadvantages of a stub-station, Mr. Buchholz proposed to divide the terminus into arrival and departure stations, the tracks in these respective stations to connect by curves running in opposite directions, with tracks laid at right angles to the axis of the station and under Green Street, thus forming a "Y," around which the arriving trains will be "tail switched" to the departure side of station. For the traffic through the tunnel it is proposed to use cable power running at a speed of fifteen miles per hour and driven by large stationary engines, and

for the "tail switching" in the station he proposes to use compressed air motors. The maximum gradient on the line would be two and a quarter per cent., which rate of grade is not heavy for cable power.

We are not advised in Mr. Buchholz's report as to the approximate cost of this work. It would, however, hardly fall short of $25,000,000, completed and ready for traffic, considering the number of tunnels proposed and the amount of property required.

The plan is open to serious objections, notably the change of motive power at the entrance to the tunnels at a point where stoppage would not otherwise be required, the use of cable power in the tunnels (necessarily at slow speed), and the "tail switching" in the station. The acquisition of such a large amount of property, which could not be utilized for other than passenger station purposes, is quite a drawback; and the proposition to accommodate the bulk of the passenger traffic of all the railroads now stopping on the New Jersey side seems to be preposterous, in view of the limited facilities proposed for the purpose.

It is not possible to satisfactorily concentrate the traffic of all the railroads on the New Jersey side, or as much thereof as would go into New York, through four single-track tunnels, nor is it at all likely that the officers of the railroad companies would submit to the propulsion of the trains by moving cables.

Tunnels, if built under the North River, should be confined to rapid transit uses. Therefore in order to utilize as much of the Hudson River tunnel as has been completed, it should be joined with a rapid transit system connecting Jersey City and Hoboken with New York City, and give up entirely the idea of running regular steam railroad trains in that way to New York.

PROJECT C.

If this project had been presented ten years ago it would doubtless have been adopted and carried out immediately, and would have proved measureably successful. At this time, however, it certainly cannot be considered a proper solution, or even a satisfactory partial solution of the problem. The transportation of railroad passenger trains on steam transports is a first-rate method where an all-rail line is for some reason or other unattainable. Its liability to delay, however, from fogs, storms, ice and interference from other river traffic makes it much more unreliable than transportation by rail, and wherever such a system is in operation we find continued efforts to substitute a bridge or a tunnel therefor, or to mitigate the vexation of irregularity in the service by constructing a round-about rail line as an alternate route.

The Thames River at New London has been bridged to obviate the use of a steam transport at that point. The Grand Trunk Railway Company has tunneled under the St. Clair River for the same purpose. Bridges and tunnels have been suggested and considered in lieu of the steam transport at Detroit, and one or the other will sooner or later be built. The most expeditious, and perhaps the most regular train transport in operation is the one at Baltimore, accommodating the trains of the Baltimore and Ohio Railroad (both freight and passenger) to and from New York and Washington. There the trip is frequently made in ten minutes from the time of stopping on one side to the time of starting on the opposite side, the route covering the Patapsco River for about one mile, and it is a frequent occurrence that people pass over the same seated in the trains of the Baltimore and Ohio Railroad and are not aware of

the fact that they have been off the main land; and yet, withal, there is a break in the continuity of the railroad, and the traffic cannot be controlled nearly so well as if the rails were continuous. Unless a company using such a system is willing to put a large investment in spare transports, they are constantly facing the possibility of a wreck or the destruction of their transports by fire, thus cutting off their traffic entirely until new boats can be secured. The Baltimore and Ohio Railroad Company take this risk and are in terror all the time, as it has but one steam transport. If it should be destroyed, it would break up the schedule of trains, and it would be compelled to split the trains and carry them over on the freight barges until another transport could be secured.

To obviate the use of the Patapsco transport, and incidentally to get its main line through the city of Baltimore, the Baltimore and Ohio Railroad Company is now building the Baltimore Belt Railroad at a cost of at least $6,000,000. For the Pennsylvania Railroad Company to adopt such a system at New York would seem like going backward, and with the exception of its providing a through route through New York to New England, instead of by way of the East River and the steamer "Maryland" service, it would present no improvements over the present plan of reaching that city.

To carry out the project properly, it would be necessary to construct steam transports to carry a solid express train, capable of high speed and of making time in all sorts of weather. That part of the river where they would ply is very much crowded with ferryboats, tugs ocean steamers, canal boats, and all other kinds of river craft not in the control of the railroad company, thus making the operation of a transport service such as outlined more or less hazardous. The landing on the New York side would necessitate crossing some streets with railroad tracks at grade, of itself a serious objection, and would locate the terminus in an undesirable part of the city. It would be quite as much of a hardship to reach this new terminus from the hotel centre as to reach either Cortlandt Street or Desbrosses Street Ferries, and the only saving a passenger would make would be the hurried transfer and long walk from the ferry at Jersey City to the train.

It is true that a union station could be established up town, in connection with such a transport service, that would have good connections with the Ninth Avenue Elevated Railroad, with the surface lines, with the New York Central and Hudson River Railroad (by way of its Eleventh Avenue line), and also with Brooklyn and Long Island by way of the proposed Forty-second Street tunnel; but with all these resultant advantages the company would not be justified in establishing the transport system as a connection for such station. This project cannot be set down in the same category with those purporting to "partially solve" this great problem, for it aims at the whole solution. It would, however, prove a temporary expedient only—a makeshift—when the demand is for a final and complete solution. Either Project D or E would provide what is sought—it is true at a very much greater outlay, but the result would be a complete system of railroads with adequate terminals in New York, and not a combination of railroads and transports.

I am far from being favorably impressed with Project C. It seems to me the day for its adoption at New York has passed, and it would prove a serious mistake to carry it out.

PROJECT D.

We now come to the consideration of the first of two propositions, either of which would furnish a good all-rail entrance into the city of New York and suitable terminals in desirable locations.

This project has been investigated by Mr. Joseph T. Richards, of your Company, and reported on quite fully It is, therefore, now unnecessary to go into the details further than is required to give a proper understanding of the project.

The recommended line, known as "The North Shore Route," would involve the construction of thirty and one-half miles of new double-track railroad, estimated by Mr. Richards to cost $52,656,508 if the Arthur Kill is tunneled, but if bridged (instead of tunneled) the total cost is estimated at $51,555,500. The through distance would be increased over the present line to the terminus at Jersey City fully ten miles, and it would be eight and one-half miles longer than to the proposed terminus of the North River Bridge Company at Sixth Avenue and Twenty-fifth to Twenty-eighth Streets, as described under Project E. The only serious obstacle to the construction of this railroad would be the tunnel, three and one-half miles long, under "The Narrows" between Staten Island and Long Island. The investigation of Mr. Richards shows that it would be impracticable to locate a tunnel within the rock formation, owing to its great depth below the surface, and he has fixed the grade for a tunnel through the silt formation at one hundred and twenty-five feet below ocean level.

The same question presents itself here that has always arisen in any discussions or examinations for tunnels under the waters of New York Harbor, *i. e.*, can a proper

tunnel be constructed through the silt formation which is there encountered that will, after completion, withstand the rack and wear and tear of heavy trains passing through it at high speed? Would not the structure "work" under the action of heavy trains? We have no precedent to go by, as all subaqueous tunnels of like construction are through a different formation than is found at New York. Therefore, it is largely a matter of speculation. In my opinion it is feasible and practicable, but would be very expensive. The grade should be raised over that proposed by Mr. Richards, so as not to exceed at any one point one hundred or, at the most, one hundred and ten feet below mean tide, for the reason that it is not right to work men in compressed air by the present known methods under higher pressure than would exist at that depth. Col. James Andrews, the contractor who constructed the foundations of the St. Louis Bridge, recently informed me that they worked men there under compressed air at the depth of one hundred and fifteen feet, and that no inducement in the world could persuade him to go one foot lower than that depth, nor to even again construct subaqueous works at the same depth.

If this line were adopted it should be built as two separate tunnels, circular in form, each carrying a single track, and lined with extraordinarily heavy cast-iron segmental plates with heavy internal flanges thoroughly bolted together, similar to but much stronger than the tunnel construction adopted at Sarnia, on the Grand Trunk Railway, on account of the difference in the character of the material through which these tunnels would be built.

The other obstacles on this route are the bridges over the Arthur Kill and the East River, neither of which, however, could be considered as extraordinary, except in the way of cost.

The principal advantages of the line would be a direct entrance to Brooklyn for railroad trains—something that is not at present enjoyed by any trunk line—and the favorable terminus in New York City.

The line would not accommodate any suburban or rapid transit traffic originating in or adjacent to Jersey City or Hoboken, so that the two tracks through the tunnel under "The Narrows," operated as an auxiliary line in connection with the present terminus at Jersey City, would perhaps answer for such traffic as would go to Brooklyn and the new terminus at Thirty-eighth Street in New York for many years to come.

PROJECT E.

The bridging of the North River has in the past been contemplated by different railroad companies, but the cost has always deterred them from undertaking it. In the course of time, however, it is almost certain to be accomplished in some manner, and in that case would undoubtedly be the preferred route into New York.

The North River Bridge Company, acting under a charter from the Congress of the United States, approved April 11th, 1890, has this project in hand. As it is a legally organized company, and as the location of the bridge and approaches thereto and the terminals therefor have been carefully made, approved by the Secretary of War and adopted by the Company, we can quote from the annual reports of the Company as filed with the Interstate Commerce Commission, as provided in Act of Congress authorizing same, and also from other reports of the Company to which we have access.

Referring to the national charter for this undertaking the Company says:—

"For such a great and commanding undertaking the incorporation powers of the two States of New York and New Jersey do not appear to be sufficient to insure legal stability for the investment of private capital.

"The Company has the most ample powers, all contained in one national charter, and does not require additional legislation, either from the States or from the cities.

"The right of eminent domain is given in the most unequivocal terms, and is based on the decisions of the Supreme Court of the United States, and therefore on the adjudicated supreme law of the land.

"The charter contains no limit to the cost of the undertaking, or to the amount of stock or bonds to be issued.

"The Company is permitted to earn net ten *per cent.* on the cash cost of the entire undertaking, but the ten per cent. applies only *to the toll from connecting railroads,* and does not apply to the income *from local traffic on the line of* the Bridge Company, nor *to the income from real estate,* so that virtually the net income of the Company may be twice as large within the meaning of its charter.

"The Company, by the express terms of its charter, contains provisions whereby it may in addition have all the powers, rights, and privileges, that other railroad or or bridge companies, chartered in the States of New York and New Jersey, may now have or hereafter acquire.

"The Company has an expressed right to enlarge its facilities and grounds whenever necessary in the future. It has the right to build and operate works and appurtenances connected with the bridge approaches and terminals, and use its real estate for any lawful purpose, besides using it for trackage room."

During the fall of 1890 the Company completed the

preliminary surveys and definitely located the bridge and approaches and submitted the plans to the Secretary of War, as provided in the Act of Congress. These plans were then referred to the Board of Army Engineers stationed in New York City, who held public hearings, and in the Spring of 1891 made their report, the substance of which was the approval of the general plans and location of the bridge, approaches, and terminals, with a recommendation that the clear height of the bridge at the centre of the middle span be fixed at one hundred and fifty feet above high water. Although the Company could have appealed from this decision and endeavored to hold the height of bridge down to the same as the Brooklyn Bridge, it was not considered advisable to do so. The plans were then revised, resubmitted to the Secretary of War for his approval, which was promptly given, and copies placed on file in the War Department at Washington. The plans for the bridge, approaches, and terminals, as approved by the Secretary of War, contemplate connections with all the railroads terminating on the New Jersey side at various points in the Hackensack Meadows, immediately west of Bergen Hill, and also a connection with the New York Central in New York and with the proposed Forty-second Street tunnel line. The distance from a connection with the Pennsylvania Railroad in the meadows to the terminus in New York on Sixth Avenue and Twenty-fifth Street (one block from Madison Square) would be only one and three-quarter miles longer than from the same point to the present terminus of Pennsylvania Railroad in Jersey City.

The line would ascend from the meadows (along the Hackensack) and pass through Bergen Hill west of Hoboken, with an open cut forty-five hundred feet long

crossing underneath all the streets in Jersey City Heights. Emerging from the Bergen Bluffs it would cross Hoboken Flats on a steel viaduct high above the buildings of the city to the western anchorage of the bridge, located at Twelfth and Bloomfield Streets, Hoboken. On the New York side the bridge would land at the foot of West Twenty-third Street, and thence the line would pass diagonally to the terminus.

The bridge will be of the type known as an Arch Suspension, having a central span thirty-one hundred feet between centres of towers, and end spans each about eighteen hundred feet. The bridge is designed with three decks; the first or lower deck of sufficient width to accommodate eight steam railroad tracks, while the second will accommodate six tracks, four of which will likely be assigned for rapid transit trains operated with electric power, and the other two for steam railroad trains. The third deck to be a promenade extending from anchorage to anchorage, reached by elevators running up through the anchorages, and also connected with the towers by elevators.

The connection with the New York Central track on Eleventh Avenue can be so arranged that through traffic need not necessarily run in and out of the station, but could pass down under the main tracks, and curving northward join the tracks on the viaduct running from the station down to Eleventh Avenue.

The great height of the bridge and approaches would permit the use of the real estate under same on New York side to be utilized for freight and storage warehouses. Property in cities like New York is far too valuable to be utilized only one story high for freight purposes. Great freight warehouses could be built on property which must necessarily be acquired, and the

cars lowered by elevators to the several stories thereof could be loaded or unloaded. The revenues from this bridge on passenger traffic alone would not be sufficient to meet the interest on the cost for many years, but the development of the real estate which is necessary, and the interchanged business with the New York Central and New England Railroads, ought to work out satisfactorily financially in a reasonable time after completion.

This passenger terminus would have a frontage on Sixth Avenue of the three blocks from Twenty-fifth to Twenty-eighth Streets, and extending from Sixth to Eighth Avenue. It could be arranged in two decks—one for through trains and one for local and suburban transit. The entire electric transit system of Jersey City, Bergen, the Palisades Plateau, Staten Island, Newark, and other nearby centers would be connected with the bridge and land passengers at this terminus in New York. The Ninth and Sixth Avenue Elevated Railways could run into the station if desired, or in any event would exchange traffic at that point. When the Forty-second Street tunnel to Long Island has been completed (and it has been granted all necessary powers), connections could be made between this terminus and Brooklyn, and rapid transit service and freight service maintained between these points.

This project for reaching New York and establishing a terminus therein is the best yet evolved. It solves the problem. It would furnish an ideal terminus in the heart of our greatest city for passenger traffic, and in addition would develop freight facilities of inestimable value, an essential feature as to the revenue. Its cost would be very great, but, when compared with the advantages, no more than its worth. It is probably more than any one

railroad company would feel justified in undertaking. Several, if not all, the railroads on the New Jersey side ought to use it and furnish their share of business towards providing for the interest on the cost. The estimated cost of the undertaking is $100,000,000, and made up as follows:—

1. Right of Way and Real Estate, assessed value $7,482,500, liberal market value $15,500,000. Estimated to cost.....	$23,000,000
2. Structures and Works, including station for twenty-eight tracks, hotel for one thousand guests, warehouses and coal and freight stations underneath tracks.....	15,500,000
Bridge seventy-four hundred feet long, capacity for ten steam railroad tracks and four rapid transit tracks..... (A double-track structure would cost $12,000,000.)	27,000,000
Viaduct in New Jersey and cut through Bergen Hill and yard in meadows.....	4,500,000
Viaduct connecting New York Central and Hudson River Railroad at Eleventh Avenue and Thirty-seventh Street.....	1,000,000
3. Interest account during construction....	10,750,000
4. Incidentals, including connections with other railroads, discount on bonds, interest for first year after completion, engineering, equipment, contingent and reserve funds.....	18,250,000
Total Cost.....	$100,000,000

The Pennsylvania Railroad Company is the most powerful and has been recognized as the most progressive on the continent. It should have a proper entrance to and terminal in the metropolis of the continent, and not be satisfied to wait for other companies with less resources and

much less need of such an improvement to point the way, as they will surely do unless it is alive and takes the initative.

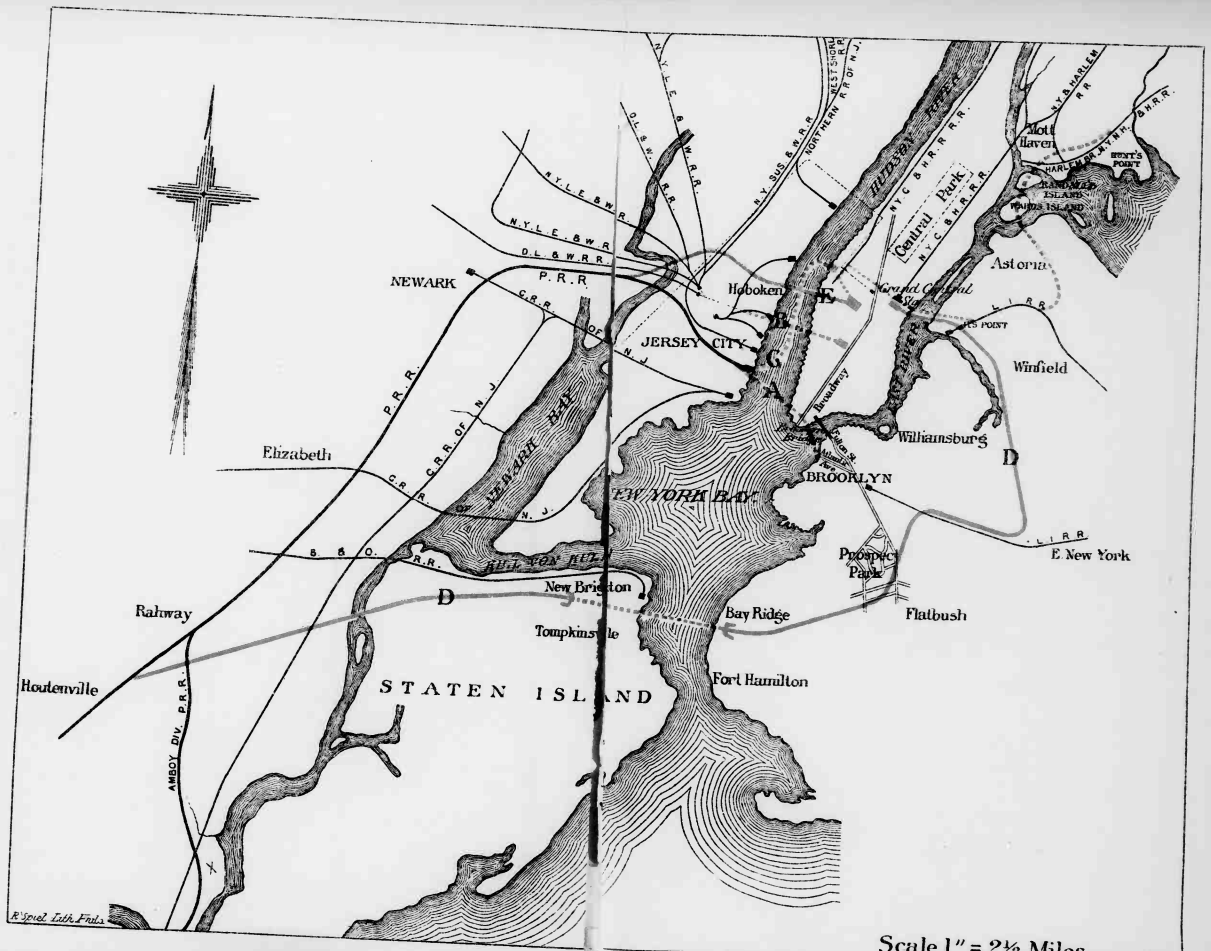
No half-way solution should be attempted by the Pennsylvania Railroad Company. It should ultimately go into New York in such a manner as to answer the needs of the Company for the next half century at least, and on an equality with, if not on a more elaborate scale, than the New York Central and Hudson River Railroad Company; notwithstanding, it may be advisable in the meantime to promote some means of rapid rail transit between the terminus in Jersey City and New York. The cost will be so great, no matter how an entrance for steam railroads to New York is effected, that anything short of furnishing facilities and accommodations for the period named would hardly justify the undertaking. Furthermore, unless such a complete plan shall be adopted and carried out, it were better to adhere to the present ferriage and lighterage systems, which, with recent improvements, are good of their kind, rather than adopt a substitute of doubtful expediency. Every year the undertaking is postponed must add enormously to the cost thereof, as property values are increasing rapidly, and the real estate required for such a work amounts to a large percentage of the total cost. If examples were needed to show the importance of the improvement, they may be found in other cities; London, for instance, is replete with railroad termini, passenger and freight. A new trunk line entrance is now proposed there, penetrating the city from the north, and the Manchester, Sheffield and Lincolnshire Railway, one of the trunk lines of England, was authorized by last Parliament to construct it. The enlargement of Waverly Station, Edinburgh, will involve an expenditure estimated at $4,000,000: the enlargement of Liverpool Street Station, London, about $10,-

000,000. To these we may add the new terminal station in St. Louis, the radical improvements to and enlargement of Broad Street Station, Philadelphia, the Reading Terminal in the same city, not to mention particularly many others long since made, as in Liverpool, Glasgow, Frankfort-on-Main, Hanover, Berlin, Cologne, and Paris. Traffic follows these improvements inevitably, as instanced in the inadequacy of such works as the Elevated Railways, the Brooklyn Bridge and Broad Street Station a few years after completion. Therefore in considering this question one must not be contracted, but must view it broadly, and summon all the experience of similar undertakings to properly lay out and plan this one—the greatest of its kind ever yet proposed. Then we should not be satisfied in simply doing something which any other railroad company may in a few years afterwards imitate. Let the Pennsylvania Railroad Company take the lead in solving the whole problem, but in so doing, as the outlay will be so enormous, it might be wise to also provide facilities for such other trunk lines as it may elect to use the same—subordinate, of course, and under its direction—and thus utilize the traffic of such lines in helping to pay the interest on the cost of the undertaking, the Pennsylvania Railroad Company, however, dominating the whole project. The railroad company that once gets control of such an entrance to New York will have much to say in, if not actually controlling, the railroad situation in the eastern part of the United States. It is not too much to say that some other railroad company, or perhaps combination of companies, may secure such an entrance to the detriment of the Pennsylvania Railroad Company, if the latter does not take immediate action in the matter.

Respectfully submitted,

SAMUEL REA,

Assistant to President.


NEWARK
JERSEY CITY
Hoboken
Elizabeth
Railway
Houtenville
STATEN ISLAND
New Brighton
Tompkinsville
Bay Ridge
Fort Hamilton
BROOKLYN
Williamsburg
Winfield
Astoria
Flatbush
E. New York
Prospect Park
Central Park
Broadway
NEW YORK B.
HUDSON RIVER
P.R.R.
N.Y.L.E.&W.R.R.
D.L.&W.R.R.
C.R.R. OF N.J.
B.&O. R.R.
AMBOY DIV. P.R.R.
N.Y.C.&H.R.R.R.
L.I.R.R.
N.Y.&HARLEM R.R.
HARLEM R.
Mott Haven
HUNT'S POINT
RANDALL'S ISLAND
PORTER ISLAND
Grand Central Sta.
Scale 1" = 2½ Miles.

MSH 20719

END OF
TITLE